February 14, 2023

Mr. Matthew Spangler
Air Quality Policy Division
Office of Air Quality Planning and Standards (C504–05)
Environmental Protection Agency
Research Triangle Park, NC 27711

Re: Prevention of Significant Deterioration (PSD) and Nonattainment New Source Review (NNSR); Reconsideration of Fugitive Emissions Rule: 87 Fed. Reg. 62,322 (Oct. 14, 2022)

Dear Mr. Spangler,

On behalf of the Distilled Spirits Council of the United States, Inc. (DISCUS), a national trade association representing producers and marketers of distilled spirits sold in the United States, we welcome the opportunity to submit comments concerning the above-referenced proposed rule issued by the Environmental Protection Agency (EPA). We respectfully urge EPA not to repeal the 2008 Fugitives Rule[1] thereby removing the New Source Review (NSR) exclusion for fugitive emissions at 40 CFR §§ 52.21 (b)(2)(v), (b)(3)(iii)(*c*), and (i)(1)(vii).[2]

DISCUS members own and operate beverage alcohol facilities that age alcohol in barrels through time-honored natural processes used for centuries to produce distilled products like Bourbon, other whiskies, rum, and other spirits. Since 1974, EPA has closely evaluated the emissions from aging warehouses and in particular the "angel's share" of ethanol that is lost to the environment during the aging process. Ethanol is a volatile organic compound (VOC) regulated by the Clean Air Act since 1970 (*hereafter* "CAA"). While we understand EPA's concern generally, fugitive emissions from aging whisky and other distilled spirits have historically and rightfully been excluded—(1) this unique industry relies on an aging process that requires contact with the ambient environment in order to achieve unique product profiles (e.g., the taste, scent, and color of aged American spirits), (2) research supports that these emissions are of little impact on the ozone, (3) EPA and other regulators have evaluated these emissions and have not identified a control that could be employed without causing irreparable damage to the product quality or that could be broadly applied to the industry, and (4) unlike other products, beverage alcohol is already highly regulated in a manner that motivates distillers to minimize product loss during the aging process through tax liabilities and mandates that the product be produced in accordance with Tax and Trade Bureau (TTB) Standards of Identity that <u>require</u> maturation of these products in this manner. Furthermore, even if controls theoretically could be achieved, the costs associated with such a program would be crippling to the nation's distilleries.

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[1] 87 Fed. Reg. at 62,322 (Oct. 14, 2022), as amended 87 Fed. Reg. at 68,119 (Nov. 14, 2022).
[2] In these comments, DISCUS has adopted the agency's shorthand, see id. at 62325, FN 4, for the NSR regulations mirrored in 40 CFR §§ 51.165, 51.66, 52.21, 52.22, and Part 51, Appendix S by referring to them collectively by reference to the provisions in 40 CFR § 52.21.

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This comment proceeds in three parts. Section I describes the unique time-honored process for aging distilled spirits and explains why prior studies have determined that spirits aging does not have the potential to significantly contribute to the atmospheric formation of ozone. While this comment uses American Whisky as an example, other distilled spirits, like rums, produced, for example, in Puerto Rico undergo similar aging processes to acquire their unique flavor and taste.[3] Section II discusses the vital fifty-year history of air pollution authority determinations around the regulation of ethanol from the aging of distilled spirits. Finally, Section III discusses critical flaws in the legal rationale provided for this proposed rule change and the injury that would be inflicted on the distilled spirits industry if adopted.

As detailed below, retaining the longstanding fugitive emissions rule and related policies is critical to preserve the integrity and sustainability of this unique industry. The distilled spirits industry as a whole continues to have grave concerns regarding the technical feasibility and reasonableness of any pollution controls that could be required by NSR for capturing and destroying fugitive emissions of ethanol and their likelihood to impair the quality and nature of the affected spirits. For all the reasons articulated herein, we respectfully urge EPA to not repeal the 2008 fugitive emissions rule or the 1980 "general fugitives exemption." In the alternative, if EPA finds that it must generally repeal the 2008 rule and fugitives exemption, these policies should be narrowly retained for beverage alcohol aging warehouses, given the longstanding exemption for fugitive emissions in the industry, inability to effectively capture fugitive emissions without impairing product quality, and minimal environmental impact of potentially capturing ethanol emissions from aging warehouses.

I.   **Longstanding Recognition by EPA that Spirits Aging is a Unique Time-Honored Process that Involves Storing Alcohol in Wooden Barrels with Access to Ambient Airflow to Create a Unique Product Profile**

Over several decades, the EPA and other state authorities have evaluated the emissions from beverage alcohol aging warehouses. The unique and time-honored way of aging spirits like Bourbon and rum is what provides the distinctive character and flavor. In fact, federal "standards of identity" regulations require that Bourbon and other American Whiskies are made by aging raw distillate produced from the fermentation of grain in new charred oak barrels.[4] The distinctive taste and quality of Bourbon has been globally recognized—and as an exceptionally American product, it was recognized by Congress as a distinctive product of the

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[3] The comments included herein mainly focus on the effects of the proposed regulation upon "American Whisky" distillers, emphasizing the importance of the aging process, the lack of reasonably available controls that also would not negatively impact product quality, and the research supporting the conclusion that EPA should not reverse its longstanding policy on fugitive emissions due to the uncertainty and irreparable harm it would cause to the American whisky industry. The points made herein, however, apply with equal force to the aging of other spirits, and specifically the aging of rum which occurs in a warmer climate and in significantly different economic and environmental conditions.

[4] 27 CFR § 5.143. This process also is described in EPA's AP-42 "Encyclopedia of Emission Factors" at Chapter 9.12.3, titled Distilled Spirits, which utilizes "Bourbon whisky production" as an example, and identifies whiskies, gins, vodkas, rums and brandies, as the most commonly produced distilled spirits for beverage purposes.

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United States in 1964 and has since been recognized by dozens of important international trading partners.

Time and again, regulators evaluating spirits aging warehouses have recognized the importance in this process and have been unable to identify any pollution controls that would not pose an imminent risk to product quality. The beverage alcohol industry, and whisky manufacturing specifically, were excluded from the New Source Performance Standards (NSPS) Priority List for the future development of CAA NSPS standards due to a lack of demonstrated air pollution control technology that did not have the potential to impair the distilled spirits, based on the findings of a 1978 EPA Engineering Study.[5] As a result, distilled spirits were not a "listed industry" in the 1980 NSR regulations pursuant to Clean Air Act Section 302(j), 42 U.S.C. 7602(j), as interpreted by *Alabama Power v. Costle.*[6] The 2008 Fugitives Rule confirmed that industries that are not "listed" in 40 CFR § 52.21(b)(1)(i)(*a*) would not be required to include fugitive emissions in determining NSR applicability decisions involving changes at a major source.[7] A general applicability provision, continuously in effect since EPA's adoption in the 1980 NSR regulations at 40 CFR § 52.21 (i)(1)(vii), likewise assures that changes at a "major source" would not be deemed a major modification if they resulted solely because of fugitive emission increases (*hereafter referred to as "the general NSR fugitives exemption"*).

These longstanding exemptions are grounded in good reason. As described below, the spirits aging process requires open access to and interaction with the environment to create the taste, scent, and color that is the hallmark of prized Bourbons and other American whiskies, as well as for other aged distilled spirits, such as brown and dark rums, among others. Furthermore, research supports that any potential environmental impact from fugitive emissions associated with aging spirits is minimal.

A. <u>Natural Ventilation and the Unique Construction of Aging Warehouses Are Critical to the Maturation of Spirits and Achieving the Distinctive Qualities of an Aged Product</u>

As noted above, federal (and many state) regulations require that American whiskies are aged in barrels, and many distillers age their Bourbon and American whisky products anywhere from two to twelve years, depending on their region of the country and the characteristics of the spirit they are trying to produce. The same is applicable to other spirits, like rums—indeed, some local regulations require distillers to age rum in barrels for at least one year and some may be aged more than 16 years (i.e., Puerto Rico).[8] Not all distilled spirits are aged the same.[9]

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[5] *See* 44 Fed Reg. 49,222, at 49,224 (Aug. 19, 1979); "Cost & Engineering Study-Control Of VOCs From Whisky Warehouses." NEIS, April 1978-450/2-78-013 at 4-9 to 4-10.
[6] *See* 323 F.2d 636 (1979).
[7] *See* 87 Fed. Reg. at 62,333.
[8] *See* 2011 PR Law 248, 13 LPRA 32483 (2011).
[9] *See* Emission Factor Documentation for AP-42, Section 9.12.3, Distilled Spirits, Final Report, March 1997 ("variations in the aging process are integral to producing the characteristic taste of a particular brand of distilled spirits. Aging practices may differ from distiller to distiller, and even for different products of the same distiller").

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The aging process requires more than just storing spirits in a barrel though—as described below, the unique product qualities are impacted by where and how those barrels are stored as well.

Fresh spirits distillate is colorless with an organoleptic profile more similar to vodka or neutral spirits than the characteristics generally attributed to Bourbon, other whisky products, or aged rum. This new distillate "ages" by undergoing many types of physical and chemical changes that impart the distinctive color, taste, and aroma that give it the characteristics the Bourbon, whisky, or rum is known for around the world.

After barrels are filled with new spirit, the barrel is placed in a covered "aging warehouse," which is open to the environment.[10] Although whisky (and other distilled spirits) aging warehouses and operations vary greatly across the industry, there are several notable hallmarks employed. Whisky aging warehouses located in the U.S., for example, are typically wood or metal-clad buildings but can also be made from brick, while Puerto Rico rum warehouses are typically constructed of masonry and metal consistent with local building codes, while keeping these sufficiently open to the environment to promote the aging process.[11] The warehouses are neither heated nor cooled because that would disturb the natural aging process. Notably, although aging facilities are commonly referred to as warehouses, they have little in common with typical warehouses where goods are simply accumulated and stored, without change, until their contents are shipped elsewhere or sold off the warehouse floor. Spirits aging facilities are actually "processing facilities" where raw spirits are transformed into saleable products, each with its own distinctive color, appearance, aroma, and flavor. [12]

Nearly all spirits aging warehouses have multiple large openings at ground level. These openings may be windows and barn doors or they may be screened and have movable panels. Importantly, it is impossible to characterize these opening as "vents" in any general understanding of that term. In Kentucky and Tennessee, for example, it is not uncommon for aging warehouses to be completely open—with multiple large barn doors and warehouse windows left open during the summer and early fall to promote a full exchange of airflow in the warehouse during the day through natural ventilation that serves to expand the raw distillate

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[10] For economic reasons, distillers ensure that barrel construction is of high quality to minimize leakage, and processes are operated to give the highest finished product alcohol yield.

[11] "Distillers utilize various warehouse designs, which include single- or multistory buildings constructed of metal, wood, brick, or masonry. Most warehouses have no climate control systems and rely on natural ambient temperature and humidity changes to drive the aging process…" *See* AP-42 Final Report, at 2-9. Installing fugitive emission controls in such buildings would impact the aging process.

[12] In the case of rum aging facilities, aged rums are older rums that have matured and lost more rum from the barrel due to evaporation. These older rums tend to carry more impressions of character, which they get from the oak casks they mature in. Aged rums can spend anything between 1 and over 16 years in oak casks.

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and draw it out into the charred oak wood barrel staves. In the winter and early spring, these windows and doors are shut to optimize the exchange of congeners between the oak charred barrel staves as the liquid cools and contracts, drawing those wood congeners into the aging spirits.

Aging warehouses differ between distilleries. Barrels of spirits can be aged on pallets that are stacked vertically on different floors of a warehouse or in "rack houses," in which the oak barrels are laid on their sides to age. Some distillers also periodically move the barrels seasonally or by year of aging to different parts of a warehouse based on natural ventilation or the orientation of a particular warehouse, or by how long the product is in storage. This is done to optimize the movement of air over the aging barrels inside the warehouse, driven by the direction and speed of the wind-driven airflow outside the warehouse. Importantly, most aging warehouses have no mechanical systems for ventilating, cooling, or heating because the equipment would interrupt the seasonal and diurnal air flow.

Aging warehouses also do not have "stacks" or equivalent openings through which emissions from the processes within are designed to be collected and vented. This is in contrast to a traditional manufacturing building in which emissions created might be collected and vented through a stack, such as a chimney or a ceiling vent, to a scrubber or other add-on pollution control like an oxidizer or biofiltration unit. Some warehouses may have a ceiling or floor fan to lower ethanol levels that may stagnate at the top or bottom of the warehouse in excess of OSHA Permissible Exposure Limits (PELs) and Fire Prevention practices, depending on their construction, ambient environmental conditions, and the season, but that is the extent of any mechanism to alter the variable air flow around barrels that ages the raw distillate.

Thus, design, temperature, and humidity inside the warehouses follow the outside environment and are highly variable during each day and depending on the season. Air movement inside the warehouse is driven by the direction and speed of the wind-driven airflow outside the warehouse. The wind pressurizes the upwind side of the building, driving air through the openings into the warehouse, where it is disrupted by the racks of barrels and dispersed. The volume of air entering through openings on the upwind side displaces an equal volume of air, which is driven out the openings on the downwind side. The magnitude of air entering and exiting the warehouse is constantly changing with the direction and speed of the wind, with all openings serving either to supply or exhaust warehouse air, depending upon the direction of the wind. Daily ambient temperature swings are moderated by the heat capacity of the stored wooden barrels that serve as either hot or cold sinks depending on the season. Changes in humidity levels in the warehouse also are somewhat stabilized by the extensive surface area of the oak barrels. The oak surface can both absorb moisture and be a source of moisture as the water in the aging product permeates through the wood.

The importance of diurnal and seasonal variations in aging products cannot be understated. Throughout the course of the year, the wind direction and speed change considerably, resulting in constantly changing ventilation rates and conditions. Over a several-year aging process, each barrel is subject to seasonal cycling of environmental conditions during

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which constituents in the wood are transferred to the bulk liquid in the barrel by simple diffusion, by convection currents in the bulk liquid, and by temperature cycling. The distinctive qualities of aged spirits are produced during aging as trace substances called congeners, which occur through (1) extraction of organic substances from the wood into the spirits, (2) oxidation of the original substances and of the extracted wood material, and (3) reaction among various organic substances present in the liquid to form the finished product. The amber color develops and the taste of the aged spirit mellows during aging as the concentration of congeners increases.

During the typical two to twelve year aging period for whisky (and one to sixteen years for other spirits like rum), alcohol and water evaporate from the barrels into the warehouse air, increasing during summer months and dropping off during cooler months. Both dynamics limit a distiller's ability to accurately measure emissions from an aging warehouse at any point in time. Therefore, EPA emission factors are calculated on the basis of annual losses measured in pounds of product lost when the aged product is withdrawn from the warehouse, averaged over the aging period for a barrel.[13]

Higher temperatures increase the rate of extraction, transfer by diffusion, and reaction. Thus, changes in the airflow around the barrel would change the alcohol concentration around the barrel and affect the diffusion rate. All of these variables are integral to a particular product brand that will have its own unique taste, color, and aroma. As EPA observed in the updated AP-42 chapter devoted to distilled spirits, the type of warehouse and its location are critical factors in imbuing each brand with its own distinctive attributes.[14]

> B. Ethanol Emissions From Spirits Aging Do Not Have The Potential To Significantly Contribute To The Atmospheric Formation of Ozone

As detailed in a petition submitted by DISCUS to EPA in 1992, emissions of ethanol from beverage alcohol have very low incremental reactivities and do not appreciably contribute to the formation of Ozone.[15] As previously recognized by EPA, some VOCs have such a low photochemical reactivity that it is appropriate to exempt them from the state ozone control programs. And, studies of VOC incremental reactivities have demonstrated that ethanol has an extremely low incremental reactivity level compared to other VOCs and at higher VOC/nitrogen oxides (NO_X) ratios. For example, ethanol has a similar incremental reactivity to methanol, which EPA has found does not contribute large quantities of oxidant under many atmospheric conditions.

> **II. Long History of EPA and State Authorities Evaluating Spirit Aging Warehouses—Categorizing Them as Fugitive Emissions and Finding No Available Controls That Would Not Impair Product Quality**

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[13] *See* EPA's AP-42 "Encyclopedia of Emission Factors" at Chapter 9.12.3, titled "Distilled Spirits."
[14] *Id.*
[15] *See* Appendix B.

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The EPA and state environmental authorities have been evaluating spirits aging warehouse emissions since the 1970s. During this time, there have been consistent findings that spirits aging warehouse emissions are fugitive and that controls may impair the product quality and are thus not reasonably available.

A. Regulatory Definition of "Fugitive Emissions" and Precedent Supports Only Considering Emissions that Can Be Quantified

Although the CAA does not specifically define "fugitive emissions," EPA has defined it. EPA first defined "fugitive emissions" as "those emissions which could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening."[16] This remains the definition in the current CAA SIP and NSR rules.[17]

The 1980 rule contained additional criteria regarding the nature of fugitive emissions in its definitions of "baseline emissions" and the "actual emission," in that those terms only require "fugitive emissions" to be considered "***to the extent quantifiable***."[18] The requirement that fugitive emissions be "quantifiable" persists in some EPA and State policy and guidance determinations discussing how to apply the definition. Thus, if fugitive emissions are highly variable, judgement is urged in whether they can be captured and counted.

B. Decades of EPA and State Regulator Findings That Aging Warehouse Emissions Are Fugitive

From 1980 onward, there have been several EPA and State regulatory and interpretative actions concerning the meaning of fugitive emissions, some of which we include in Appendix A for the Agency's consideration. Several of these actions are particularly important because they are related to whether EPA viewed emissions from whisky aging warehouses as fugitive. It bears noting that the referenced precedent below and supporting materials in Appendix A are just a portion of the history on the topic.

Of note, several of these discuss the hurdles to reasonably collect aging warehouse emissions and have specific findings that they are fugitive. For example, on June 27, 1994, Kentucky's Natural Resources and Environmental Protection Cabinet issued a declaration that stated, "[a]s with emissions from whisky barrels, the Cabinet considers ***ethanol emissions from aging warehouses to be fugitive emissions*** as defined in Regulation 401 KAR Chapters 50 and 51."[19] The following month, on August 19, 1994, EPA Region 4 issued a determination that after

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[16] *See* 48 Fed. Reg. at 38743 (August 25, 1983).

[17] *See* 40 CFR §§ 70.2 and 71.25.

[18] *See* 45 Fed. Reg. at 52692 (August 7, 1980) (emphasis added).

[19] *See* Appendix A; Kentucky Department of Environmental Protection Letter Regarding Aging Warehouse Fugitive Emissions Determination (June 27, 1994) (emphasis added).

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consulting with EPA Headquarters, "EPA does *not* consider windows and screen openings at whisky warehouses to fall with the definition of stacks or functionally equivalent openings," and therefore it would consider evaporative emissions from whisky warehouses to be fugitive emissions.[20]

On February 10, 1999, EPA Office of Air Quality Planning and Standards (OAQPS) responded to a request from Region 3 for guidance on how the definition of fugitive emissions applies to VOCs emissions from whisky aging warehouses and other similar sources by issuing guidance titled "Interpretation of the Definition of Fugitive Emissions in Parts 70 and 71."[21] The Interpretation states:

> In the case of whisky warehouses, the presumption that emissions could reasonably be collected is less compelling and may warrant further consideration by States in consultation with the EPA Regional Offices. For example, we are not aware of any national standards or SIP requirements for the collection of VOC emissions from whisky warehouses, and we believe it is uncommon for them to have voluntarily installed collection devices. On the other hand, EPA is aware of warehouses in other source categories that collect emissions and thus a presumption is created that whisky warehouse emissions could reasonably be collected. In addition, in a factual determination for a whisky warehouse in the State of Indiana, EPA Region V found, after careful review, that the emissions of the warehouse were not fugitive.[22]

Then, on August 4, 2004, Indiana's Office of Environmental Adjudication (OEA) dismissed a finding by U.S. EPA Region 5 that VOC emissions from Seagram's whisky aging warehouses were "stack emissions," which required the distiller to obtain a Clean Air Act Title V Operating Permit, ruling:

> The Petitioner has presented extensive evidence regarding the whisky aging process and the effect the collection of ethanol emissions would have on

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[20] *See* Appendix A; EPA Region IV Letter Regarding Fugitives Emissions from Whisky Aging Warehouses (August 19, 1994).

[21] *See* Appendix A; EPA Policy Memo, "Interpretation of the Definition of Fugitive Emissions in Parts 70 and 71 (February 10, 1999). **Background:** Prior to July 3, 1996, EPA Region 3 conveyed its view to the Maryland Department of the Environment (MDE) that any emission generated inside an enclosed structure is a "stack emission." On December 24, 1998, in a Letter to the Editor of CLEAN AIR REPORT, MDE's Director of Air & Radiation Management vigorously disputed Region 3's determination, noting that MDE's July 3, 1996 formal request to Region 3 for guidance on fugitive emissions remained unanswered. The Director stated that MDE interpreted the phrase "reasonably pass through a stack, chimney, vent or functional openings" in EPA's definition of fugitive emissions to allow MDE to consider "reasonableness factors" such as cost and industry-wide practices when characterizing a source's emissions as either stack or fugitive. She also cited Region 4's determination that emissions from whisky aging warehouses are fugitive emissions.

[22] *Id*. at 3.

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this process. The Petitioner has shown by a preponderance of the evidence that the ***collection of the ethanol emissions would negatively affect product quality***. The Petitioner has also presented sufficient evidence to prove that such emissions are not collected at other similar facilities and that ***U.S. EPA has not identified any reasonably available control technology (RACT)*** for ethanol emissions from alcohol beverage aging warehouses. Based on the evidentiary matter before it, this Court concludes that there is no genuine issue to any material fact. The Petitioner has met its burden of proof by a preponderance of the evidence in this matter. The ***emissions from the Facility are fugitive emissions***, therefore, the Facility is not a major source under 40 CFR § 70.2 or 326 IAC 2-7-1(22) and it is not required to obtain a permit under 40 CFR Part 70 or 326 IAC 2-7."[23]

C. <u>EPA and State Authorities Also Have Determined That Controls for Whisky Aging Warehouses are Not Feasible</u>

After careful evaluation, the EPA and state authorities have concluded on numerous occasions that there is no reasonably available control technology (RACT) for whisky aging warehouses.

1. *Statutory and Regulatory Background*

It is understood that VOCs and NOx emitted from stationary, mobile and biogenic sources are precursors to the atmospheric formation of ozone through a series of complex atmospheric reactions between VOC compounds with NOx in the presence of sunlight, generally over significant residence times as emissions are transported downwind. Ethanol is regarded as a low-reactive on VOC reactivity tables, but reactivity is not required to be considered by the Clean Air Act, although EPA now acknowledges its importance in secondary formation of ozone from NOx emissions.

CAA Title I contains three principle pollution control requirements for the reduction of ozone and its precursors VOCs and NOx: (1) Existing Major Source Reasonably Available Control Technology (RACT) in Ozone Nonattainment Areas; (2) New Major Source and Major Modification Best Available Control Technology (BACT) in Attainment Areas to Prevent Significant Deterioration of air quality; and (3) New Major Source and Major Modification Lowest Achievable Emission Reductions (LAER) in Nonattainment Ozone areas.

The 1990 CAA amendments mandated that nonattainment states adopt RACT standards equivalent to or more stringent than prescribed by EPA Control Technique Guidelines ("CTGs") and Alternative Control Techniques ("ACTs") for certain industry sectors. Further, the amendments require States to perform case-by-case RACT determinations for all "major

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[23] *See* Appendix A; August 4, 2004; Indiana Office of Environmental Adjudication Findings of Fact, Conclusions of Law, and Final Order Regarding Aging Warehouse Fugitive Emissions; Objection to the Issuance of Part 70 Operating Permit No. T-137-6928-00011 for Joseph E. Seagram & Sons, Inc. at pg. 7 (emphasis added).

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sources" for which an EPA CTG or ACT does not exist, or make a "negative RACT determination" for "major sources" (in other words, no reasonable controls are available). In the case of a "negative RACT determination," the RACT is thus determined to be "no controls."

There is no CTG or ACT for the distilled spirits industry or any beverages. We are unaware of any state having identified a RACT for whisky or rum aging warehouses. Undoubtedly, this is in part because they are deemed to be sources of "fugitive emissions" that are not included in "major source determinations." However, despite a general State agreement that aging whisky warehouses are not "major sources," negative RACT determinations were made by several States in their 1997 Ozone RACT submittals, including Ohio, Maryland, and Louisville, Kentucky. These RACT determinations are discussed below.

>   2. *EPA Unable to Develop CTG and Reports That Potential Controls Could Impact Whisky Quality*

In 1974, EPA OAQPS contracted PEDCo to conduct an engineering review of controls for emissions from whisky aging warehouses, which was intended to form the basis of a CTG for capturing and controlling these sources of VOCs. In 1978, on the basis of PEDCo's study, EPA OAQPS staff published a Report titled "Cost & Engineering Study-Control Of VOCs From Whisky Warehouses."[24] In the Report, EPA concluded that while pollution controls were available to reduce ethanol emissions from aging warehouses, "whisky quality could be affected if carbon adsorption system altered such warehouse conditions as temperature, humidity, and ventilation."[25]

The report also noted that, even if a carbon adsorption unit might be designed with straightforward engineering and at a moderate cost, the unique and variable nature of whisky aging creates other challenges to finding a broad solution suitable for the industry at large:

> [T]he proper design is not the only criterion; it is important to know what conditions to reproduce. Given the complex nature of whisky aging, it is difficult to state precisely what are (sic) the conditions for proper aging, and thus how to design the CA system. This is especially true considering the number of different brands of whisky. Development of the system through experimentation is also difficult. . . Thus, the CA system's effect on whisky quality is indeterminate. It would appear possible to design a system to reproduce the desired conditions but not possible to state with precision what these conditions are.[26]

Since 1978, EPA has not attempted to publish a CTG or ACT for whisky aging warehouses, despite having updated the CTGs/ACTs several times for various industry sectors that emit

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[24] *See* NEIS, April 1978-450-78-013.
[25] *See id.* at 1-3; 4-8; 4-16.
[26] *See id* at 4-9 to 4-10.

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VOCs. The above-rationale remains viable today and applies with equal force to whisky and the production and aging of other spirits, such as rum.

3. *EPA Confirmation that RACT or Other Clean Air Act Emission Controls are Not Available for Whisky Aging Warehouses*

Beginning in 1979, EPA confirmed in the CAA Section 302(j) rulemaking that no demonstrated control technology was available for whisky manufacturing.[27] EPA's encyclopedia of emissions factors, the Compilation of Emission Factors known as the AP-42, also confirms that no whisky aging warehouse was subject to RACT or any other emissions controls:

> Add-on air pollution control devices for whisky aging warehouses are not used because of the anticipated adverse impact that such systems would have on product quality. For economic reasons, distillers ensure that barrel construction is of high quality to minimize leakage, and processes are operated to give the highest finished product alcohol yield. If feasible without impairment of product quality, ethanol recovery would require the use of a collection system to capture gaseous emissions in the warehouse and to process the gases through a recovery system prior to venting them to the atmosphere or recirculating them through the warehouse.[28]

4. *EPA Informed Congress That There Is No Reasonable Controls for Aging Warehouses and Thus States Were Not Required to Control Them*

On October 23, 2000, in response to a letter from Senator Bob Smith, Chairman of the Senate Environment & Public Works Committee, regarding his inquiry into whether EPA has identified RACT for ethanol emissions from alcohol beverage aging warehouses, EPA Headquarters informed Senator Smith that:

> One control technology which has been suggested in this regard is carbon adsorption which conceivably could be applied to the warehouse ventilation exhaust to capture ethanol fumes. However, in order to capture the warehouse fumes[,] it may be necessary to modify the air flowing through the warehouse which could affect temperature, humidity and ventilation in the warehouse. The industry has raised questions about whether these changes would adversely affect the product quality. *** Due to this unresolved issue, EPA has not, at this time, declared that such add-on control devices are RACT for alcohol beverage aging warehouses. Nor has EPA currently identified any other available technology which it considers to be RACT for alcohol beverage aging warehouses. Therefore,

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[27] *See* 44 Fed. Reg. at 49222 (Aug. 21, 1979).

[28] *See* Appendix A; EPA, Documentation for AP-42 Emission Factors for Distilled Spirits, Contract 68-D2-0159 Work Assignment No. 4-04. MRI Project No. 4604-04 (March 1997) at page 2-12.

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EPA is not requiring states to control these sources in order to meet ozone control state implementation plan requirements.[29]

5. *State Authorities Find That No Reasonable Controls Are Available for Whisky Aging Warehouses*

To our knowledge, no state has found reasonable controls (RACT) that would be available for whisky aging warehouses. However, several states have evaluated the matter and have come to negative RACT determinations, including Kentucky, Maryland, and Ohio.

Kentucky

As part of its 1997 ozone NAAQS SIP-planning, JAPCD/METRO undertook two RACT-related rulemakings. During both rulemakings, JAPCD/METRO reviewed and determined that no pollution controls were "reasonably available" for emissions from Bourbon aging warehouses operating under its jurisdiction. Early in the development of proposed Rule 6.43, JAPCD concluded that control of "fugitive emissions" from rack-style metal clad warehouses, would be both technically and economically infeasible because ethanol could not be "reasonably captured or controlled" from the warehouse. Eventually, JACPD determined that none of the Bourbon aging warehouses in Louisville and the surrounding counties could reduce emissions from their aging warehouses without product impairment.

As part of its analysis, the agency required a distiller to conduct a test examining whether beverage alcohol could be collected inside their aging warehouse and destroyed by a biofiltration unit. The test failed at least twice during summer of 1996, reportedly for technical problems related to collecting the highly variable VOC emissions inside the warehouse environment to maintain a continuous high volume-low concentration airstream sufficient to be treated by biofiltration.

The Jefferson County Air Pollution Control Board ultimately voted 4-0 against Metro's proposed adoption of Rule 6.51 on May 9, 2003, finding that additional pollution controls were unnecessary to maintain the 1997 standard and attain and maintain the 2008 ozone NAAQS. EPA approved Metro's ozone attainment re-designation request without RACT control requirements on whisky aging warehouses.

Maryland

On July 14, 2000, the Maryland Department of the Environment (MDE) published proposed COMAR 26.11.19, a RACT rule for distilled spirits facilities that required good work practices for barrel dumping and filling operations at the Seagram Relay distillery, but did *not* include pollution control requirements for whisky aging warehouses. Concurrently, MDE

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[29] *See* Appendix A; EPA Letter to Senator Robert Smith Regarding RACT for Aging Warehouses (October 23, 2000).

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undertook a case-by-case RACT review of the Seagram Relay whisky aging warehouses, to corroborate its view that control of fugitive emissions from the whisky aging warehouses was not feasible. The Technical Support Document for final RACT Rule COMAR 26.11.19.29, promulgated in October 2000, stated that "interference with the breathing of the barrels or changing the airflow interfere with the product quality. Accordingly, the intent and scope of the provisions of MDE Regulation 26.11.19.29 are predicated upon the recognition and appreciation of this product impact on the aging process for distilled spirit." EPA Region 3 subsequently approved the final revised rule on October 7, 2001 as part of the Maryland 1997 Ozone NAAQS SIP.[30]

Ohio

As part of its 1997 ozone NAAQS SIP-planning, Ohio also came to a negative RACT determination. Pursuant to Ohio's VOC RACT Rule, Seagram and Sons submitted a "RACT Evaluation For Emission Sources Subject To OAC Rule 3745-21·11" for its Shandon, Ohio Whisky Storage Facility. Ohio law required a RACT study for all sources of 100 tons of VOCs if they were not already regulated. The RACT study contended that ethyl alcohol emissions cannot be collected from the wooden barrels in which whisky is aged without adversely affecting product quality and thus none of the four available pollution control technologies to be considered under Ohio law were considered technically feasible. Based upon their full evaluation of the facts, Ohio elected not to adopt control requirements for the warehouse in its 1997 SIP Submission.

San Joaquin Valley Brandy Warehouse Controls Not Applicable to the Aging of Whisky or Rum

One local air pollution control jurisdiction, the San Joaquin Valley Air Pollution Control District (SJAPCD), has implemented a RACT standard applicable to brandy aging warehouses and this standard has been referenced in potential RACT/BACT/LAER determinations for whisky warehouses. Ultimately, however, the technical achievability of the California standard requires a comparison of the design of the aging warehouses and other factors in San Joaquin's adoption of that standard, which clearly demonstrates that this technology does not appropriately transfer from one type of spirits warehouse to another.

In May 2007, the Valley promulgated a Best Available Retrofit Control Technology ("BARCT") applicable to wine fermentation and storage operations. Among its requirements for capture of VOCs from fermentation and storage vessels at wineries, proposed Local Rule 4694 allowed Certified Emission Reduction Credits (CERs) from other sources that were either not regulated or could be regulated beyond existing federal and state emission standards.

After Local Rule 4694 was adopted, owners and operators of wineries subject to the regulation met with SJAPCD and fearing contamination issues from reducing ethanol from

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[30] *See* 66 Fed. Reg. at 22924 (October 7, 2001).

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fermenters and storage vessels in wineries, they proposed testing whether they could control ethanol emissions from three brandy aging warehouses operated in the San Joaquin Valley to produce Certified Emission Reductions (CERs) instead of complying with SJAPCD Rule 4694. The SJAPCD approved a pilot test of such controls at three brandy warehouses under their jurisdiction, which were ultimately successful and produced enough CERs to "offset" the forecasted small VOC reductions from implementing Rule 4694. Thereafter, the SJAPCD proposed and adopted Local Rule 4695 for the reduction of VOCs from brandy aging warehouses.

Throughout the consideration of the proposed rule, SJAPCD officials solicited input from whisky manufacturers, who in turn submitted information to the SJAPCD concerning the differences between the construction and design of brandy and whisky aging warehouses. It was evident that the brandy warehouses were quite different than typical spirits aging warehouses.

In recommending adoption of Rule 4695, SJAPCD's Staff Report to the San Joaquin Air Quality Control Board appropriately emphasized the important differences between aging brandy and whisky, stating:

> The District staff understands that the nature of whisky aging operations differs from wine and brandy aging. Specifically, the ambient conditions, such as storage temperature and humidity, as well as seasonal variations, are important factors in the whisky aging process. All aging processes, depends upon the interaction of product in oak barrels, whisky aging operations strive for a particular blend of temperature, humidity, and ventilation, leading to different types of warehouse. (Source: EPA, Final Report: Emission Factor Documentation for AP-42, Section 9.12.3, Distilled Spirits, p. 2-7 (March 1997).) Therefore, whisky aging is not considered or included in this rule development process. [31]

Based upon the differences discussed above related to whisky aging warehouses, it is evident that the same RACT controls used on brandy aging warehouses in San Joaquin are not a reasonable option and would dramatically alter the natural aging process and product quality. The same could be argued for other spirits, similar in aging nature to whisky, such as rums. The Draft Staff Report, in Appendix C, Table 1-A, estimated the capital costs for a brandy warehouse utilizing thermal oxidation with a capacity of 806 barrels to be $195,000. This works out to be approximately $242/barrel stored. While this is not entirely indicative as to the anticipated costs to whisky or rum aging, it does help to put a scale to these potential costs for every impacted distiller—a figure which, if comparable, we believe could put many in our industry out of business.

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[31] SJAPCD Final Draft Staff Report for Rule 4695, pp.2-3, September 17, 2009.

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Given this lengthy history of fugitive and no-RACT determinations, it is evident that whisky and other spirits (i.e., rum) aging warehouses are designed to promote the interaction of ambient environmental conditions with the barrels and that the typical spirits aging warehouse is distinctly different from brandy warehouses or typical warehouses where industrial products are stored. In the context of this rulemaking, EPA should continue their longstanding policy of concluding that the emissions from aging warehouses are not capable of being collected and are, thus, "fugitive." If this instant proposal is indeed adopted, we respectfully request, at a minimum, that distilled spirits aging warehouses be exempted from its scope and that the 2008 rule and fugitive emissions exemption be retained for spirits aging warehouses.

Further, EPA should find separately that pollution controls, including controls like those required by SJAPCD Rule 4695, are not technically feasible for typical whisky or spirits aging warehouses because their application will dramatically alter the aging warehouse environment that is so critical to the ultimate product quality. If this rulemaking is finalized as proposed and distilled spirits aging processes are not excluded from its scope, distillers around the country who have been adhering to and cooperating with EPA determinations for years will be financially upended and gravely penalized—and all to accomplish a negligible impact on VOCs in their Regions. Furthermore, as explored in the following section, requiring distillers to include fugitive emissions in their "major modifications" and/or requiring RACT to be installed or tested, on aging warehouses is arbitrary, capricious, and without commensurate benefit to the EPA's mission.

III.   **Proposed Regulatory Changes Lack a Valid Legal Rationale and Would Be Arbitrary and Capricious**

EPA makes two arguments for repealing the 2008 Fugitives Rule and the 1980 general fugitives exemption from major modification determinations for unlisted Section 302(j) source categories. First, the Agency argues on several grounds that both provisions must be repealed on the basis of the plain language of the CAA. Second, the Agency argues alternatively that, *were* the CAA ambiguous about excluding fugitive emissions from major modifications, it has ample discretion under the *Chevron Doctrine* to remove those provisions to better achieve the goals of the Act and eliminate confusion. We respectfully disagree with both rationales and believe that the general NSR exemption for fugitives from major modifications is good public policy, particularly with regard to spirits aging warehouses.

A.   Contention that Repealing the NSR Regulatory Exemptions of Fugitive Emissions from NSR "Major Modification" Determinations is Compelled by the "Plain Language" is in Error

The assertion in the NPRM that the law requires it to repeal the exclusion of fugitive emissions from NSR "major modification" determinations for certain industries that were not part of a 302(j) rulemaking is not only a misreading of the CAA, but also contrary to the CAA's plain language and a fully litigated record on this topic. The definition of a "major source" by

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Section 302(j) is not, on its face, determinative of whether a "modification of a major source" was intended by Congress to also exclude fugitive emissions from "major modifications." There is no definition of "modification" or "major modification" in the CAA's general definitions for good reason. While the term "major source" is used throughout Title I of the Act as a general term, "modification" is a programmatic term, confined to the NSPS and NSR programs in Title I of the Act. Thus, it is not surprising, nor determinative, that Congress would not include a definition of "modification" in the general statutory definitions in CAA Section 302, much less the general statutory definition of a "major source" in CAA Section 302(j).

The EPA argues that the Section 302(j) definition of "major stationary source" and "major emitting facility"—together "major source"—is silent as to how fugitive emissions are to be treated in the case of a modification to an existing source.[32] Thus, EPA concludes that it must look *only* to the Section 111(a)(4) definition of "modification" for guidance on how to treat fugitive emissions that result from a change at an existing source. EPA's reliance on Chevron Step 1 and the Plain Language Doctrine is misplaced. Silence in Section 302(j) as to how modifications are to be treated does not mean that Section 302(j) is irrelevant to which modifications can trigger major new source review.

Section 302(j) is relevant to defining the set of fugitive emission sources to which all other aspects of the NSR program could potentially apply. These other aspects of NSR include the prohibition on construction without a permit in Section 165(a), the inclusion of modification as a form of construction in Section 169(2)(C), and the definition of modification in Section 111(a)(4). That is, unless a source type has been included in an EPA rule as a source type for which fugitive emissions will contribute to the source's potential to emit, no other provisions of the preconstruction program can apply to fugitive emissions at that source type. In other words, Section 302(j) defines the set of all fugitive sources that *could be* subject to NSR (and those that could not), while the other CAA provisions define the conditions under which the included set of fugitive sources actually trigger NSR.

The legislative history on CAA Section 302(j), while "sparse,"[33] is also relevant and reveals the Drafters' concerns regarding the reasonableness of requiring all industries to collect fugitive emissions and calculate them for purpose of regulating them under the Act. Indeed, the legislative history reflects a general awareness and concern by Congress about regulating fugitive emissions at all from any source, small or large under NSR or the CAA generally, if it is difficult to capture them, calculate them, and control them. That concern is reflected in the NSPS rulemaking that EPA issued in 1979, "New Source Performance Standard Priority Rule,"[34] to respond to *Alabama Power Co. v. Costle*'s remand of the 1978 NSR regulations to EPA for its failure to consider fugitive emissions. This rule considers at length whether it is "reasonable" to regulate fugitive emissions from various industry categories, regardless if they are

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[32] *See* 87 Fed. Reg. at 62,322, 62,331 (Oct. 14, 2022) ("Given CAA section 302(j)'s silence with respect to modifications, in conjunction with the definition of "modification" in CAA section 111(a)(4), the EPA does not believe the CAA section 302(j) rulemaking requirement applies to major modification determinations.").
[33] *See* 87 Fed. Reg. at 62,334.
[34] *See* 44 Fed. Reg. at 49,222 (Aug. 21, 1979).

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"modifications," defined in CAA Section 111(a)(4) of the Act—the same section of the Act that the instant 2022 NPRM insists prohibits the exclusion of fugitive emissions from the definition of a "major modification" under the New Source Review (NSR) program.

Also, Congress's general concern about calculating and including fugitive emissions at all in "major source" determinations throughout the Act's implementation is explored in *Alabama Power Co. v. Costle,*[35] in which the Court held that Congress clearly intended the Administrator to conduct a rulemaking to determine if it was reasonable to include "fugitive emissions" from any industry source category in determining if they should be regulated by the CAA as a "major source." In other words, the Court acknowledged that if the capture of fugitive emissions was not reasonable from certain types of source categories, the source could not be a "major source" or regulated as such.

As a practical matter, it is hard to imagine that it would be technically more feasible to capture and collect a smaller quantity of fugitive emissions from a modification of the sources that were excluded from the definition of "major source." The instant proposed rule change appears to suggest that stakeholders should not be concerned by this issue because a physical change or change in the method of operation of a source is only regulated if it occurs at a "major source," for which EPA already has concluded fugitives are not included and therefore, would not often be defined as "major modifications."[36] Despite these reassurances, this is very concerning for the spirits industry which may include those who are otherwise categorized as "major sources" and also operating aging warehouses with fugitive emissions.

The EPA's clear use of the legislative history behind CAA Section 302(j) to reassure stakeholders that were omitted from "major source" categories because of fugitive emissions belies the agency's insistence that it should be ignored in a "plain language" interpretation of the Act. It is nonsensical to assume that the silence or absence of the term "major modification" in the definition of a "major source" necessitates the repeal the 2008 Fugitives Rule and 40 CFR §52.21(i)(1)(vii). It is far more reasonable to deduce that Congress's silence in Section 302(j) on this point meant that fugitive emissions should be treated the same for "major source modifications" as they are for "major sources"—excluding them from those categories for which it was not reasonable to calculate, capture, or control fugitives from the source category.

B. <u>Proposal Misstates the Law to Support Claim That the Statutory Definition of "Modification" in the NSPS Program Must Be Applied in NSR Review</u>

The instant proposal argues that the 2008 Fugitives Rule and the 1980 "general exemption" must be repealed for two other reasons under the "plain language" doctrine. First, it argues that Congress incorporated by reference the definition of "modification" found in Section 111(a)(4) of the CAA NSPS Program and in the NSR program at CAA Sections 169 and

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[35] *See* 636 F.2d 323, at 369-70.
[36] *See* 87 Fed. Reg. at 62,331.

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173 of the PSD and NNSR programs, respectively. We understand that the Agency itself does not use the definition of "modification" set forth in CAA Section 111(a)(4) to determine if a modification to an "affected" NSPS source occurs, so it is unclear why it is now being argued that this definition should apply to the NSR program. Specifically, the NSPS regulations at 40 CFR §§ 60.14, which interpret the CAA's definition of "modification" at Section 111(a)(4), not only do not apply a NSPS to an "affected source" for "any emission increase," but there are a raft of other qualifications and exclusions from the definition that have actually resulted in few applications of an NSPS to an affected source over the last fifty years.

Second, the agency erroneously argues that the D.C. Circuit held in *New York v. EPA*, 413 F.3d 3 (2005) (*New York* I"), and *New York v. EPA*, 443 F.3d 880 (2006) (*"New York II"*), that "any emission increase" at a "major source" would violate the NSPS definition of "modification." The agency is not only flatly misconstruing these precedents in their proposal, but it's clear that these opinions actually have little to no bearing on the agency's legal ability to allow certain types of "unlisted industries" to exclude fugitive emissions from "major modification" determinations under CAA Sections 169 and 171(4). Moreover, neither *New York I or New York II* examined the fundamental differences in how NSPS and NSR regulations interpret the Section 111(a)(4) definition of "modification," or in the case of the 2008 *New York II* decision, how it was affected by the U.S. Supreme Court's opinion in *Environmental Defense Fund v. Duke Energy*.[37] *Duke Energy* held that while a term may be used more than once in a statute, an agency has the discretion to interpret each use of the term in a different way based on its statutory purpose and context.[38] In view of the Supreme Court's unambiguous interpretation that the statutory NSPS definition of the term "modification" does not, and need not, mean the same thing in the definition of the PSD program as it does in the NSPS rules, EPA's basis for repealing the 2008 Fugitives Rule and 1980 General Fugitives Exemption is in error.

C. Proposal Does Not Comply With the "*Chevron Doctrine*"—It Is Not Consistent With the CAA and Is Not Reasonable

Although EPA does *not* concede that it lacks a clear signal from Congress on the inclusion of fugitive emissions in major modifications for all industries, despite the 302(j) rulemaking, the proposed rulemaking presents an alternative argument that if the statutory definition of "modification" was found to be ambiguous, then EPA has ample discretion pursuant to the second prong of the *Chevron Doctrine* to craft a reasonable regulation that is consistent with the statute in its place.[39] We respectfully submit that the proposed rulemaking is neither consistent with the statutory or regulatory design of the CAA's NSR provisions, nor a reasonable regulatory response based on balancing the dual environmental health and economic purposes of the NSR program. Therefore, the proposal also should be withdrawn because it fails Part 2 of the Chevron Doctrine.

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[37] *See* 549 U.S. 561 (2007).
[38] *Id.*
[39] *See* 87 Fed. Reg. at 62330.

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It is wholly unreasonable for EPA to argue that there is ambiguity on the issue of fugitive emissions from certain industries for which the agency did not undertake any kind of NSR applicability determination, whether for a "major source" or a "major modification." However sparse the legislative history on this issue, Congress did indeed contemplate the difficulty of calculating and/or capturing and controlling fugitive emissions for unlisted source industries in the context of a "major modification."[40] And, as noted above, the history of EPA and state determinations and enforcement actions further support this difficulty for the distilled spirits industry in terms of managing fugitive emissions from aging warehouses. On this basis, EPA's analysis of *Chevron* in terms of consistency with the CAA and its legislative history of Section 302(j) are in error.

1. *Proposed Rule is Not Consistent with the Clean Air Act*

Congress, as previously discussed, clearly recognized the difficulty of capturing and measuring fugitive emissions from certain industries and thus required the Administrator to conduct a rulemaking before coming to a determination on this issue. Further, from a technical view it is no easier, and potentially more difficult, to capture and calculate a small amount of fugitive emissions—particularly if they are naturally intermittent and dependent on environmental factors. This technical finding has been affirmed by EPA and state and local agencies as the basis for not listing certain industry categories and requiring them to include fugitives in determining if they are "major sources" under Section 302(j).

If the EPA insists that the Act is ambiguous regarding how to treat modifications that increase fugitives, the EPA must give effect to all relevant statutory provisions, not simply the Section 111(a)(4) definition of modification. This effort must include the interface between Sections 302(j), 165(a), 169(2)(C), and 111(a)(4). The agency's conclusion that CAA Section 111(a)(4) is the *only* provision relevant to modifications that result in increases in fugitive emissions—and the EPA's failure to give any meaning to Section 302(j)—is unreasonable in light of forty years of the agency's historical interpretations of the three statutory provisions.

The D.C. Circuit necessarily implies this interpretation in *Alabama Power*, in which the court addressed whether the EPA had lawfully promulgated a "fugitive dust" exemption from NSR permitting.

> EPA is correct that a major emitting facility is subject to the requirements of 165 for each pollutant it emits irrespective of the manner in which it is emitted. However, a source emitting large quantities of fugitive emissions may remain outside the definition of major emitting facility and thus may not be subject to the requirements of section 165.[41]

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[40] *See Alabama Power v. Costle*, 636 F.2d 323 at 369-70.
[41] *Id.* at 369.

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The court appears to state that before *any* of the requirements of Section 165 may be applicable to a source emitting fugitive emissions, EPA must have by rule included that type of source as one for which fugitive emissions are relevant. Because Section 165 restricts the construction of a new source *and* the modification of an existing source, we would argue that the Section 302(j) condition precedent must apply to both types of restriction.

The D.C. Circuit did not disturb this reasoning in *Nat'l Mining Ass'n v. EPA,*[42] in which the court addressed whether Section 302(j) restricted the inclusion of fugitive emissions of hazardous air pollutants under Section 112. The court concluded that there was a "notable difference" in the definition of "major source" under Section 112 and the Section 302(j) definition, such that an *Alabama Power*-based argument was not persuasive.[43] We do not believe that EPA will easily be able to show a "notable difference" between its acceptance of Section 302(j) to decide whether the construction of a new major source requires a permit, and its rejection of Section 302(j) to decide whether a modification to an existing major source requires a permit.

From a public policy perspective, we observe that EPA entirely fails to provide any data to support its assertion that the benefits to public health clearly outweigh the costs to regulated entities. In fact, the Notice acknowledges that the rulemaking's costs of capturing and controlling fugitive emissions from sources at which "major modifications" take place will reasonably fall on large regulated sources.[44] The agency's statements in this regard are dissonant with the purpose clauses of the CAA requiring the EPA to accurately weigh the conflicting environmental health and economic purposes to both "protect and enhance the quality of the national's air resources so as to promote the public health *and welfare and the productive capacity of its population* (*emphasis added*)."[45] For industries that were not listed in the NSPS Priority Rule under Section 302(j) because the EPA explicitly concluded that it was not reasonable to regulate fugitive emissions for technical and/or economic reasons, it also appears to defy the rulemaking that EPA did in 1979 to conclude that these emissions were not reasonable to capture or control, nor updated that rulemaking by adding source categories for which the capture and control of fugitive emissions would be reasonable.

Moreover, in what appears to be an attempt to make the purported Chevron "discretion" seem reasonable, the agency appears to argue that sources of predominantly fugitive emissions would continue to be exempt from NSR review because "NSR 101" states that NSR would not apply to "major modifications" of fugitive emissions alone unless the "source" is in the first reckoning, a "major source."[46] Thus, EPA is putting forward that the rule does not exactly ignore Congressional intent that is clearly expressed with regard to a rulemaking concluding that fugitive emissions can be captured and calculated, by trying to reassure some industry stakeholders that injury from the rulemaking "will be limited" to just

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[42] *See* 59 F.3d 1351 (D.C. Cir. 1995).

[43] *See id.* at 1360–61.

[44] *Id.* at 62334.

[45] *See* CAA Section 101(b)(1), 42 U.S.C. § 7401(b)(1).

[46] *See* 87 Fed. Reg. at 62334.

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those unfortunate enough to also be a "major source" in a determination that did not have to account for fugitive emissions. In addition to creating internal inconsistencies in the reasoning of this rulemaking, the agency sidestepping also raises questions about whether this policy change will lead to the claimed benefits—if the impact on industry is to be so modest, how then will there be significant benefits to the environment and health.

2. *Proposed Rule is Arbitrary and Capricious Because The Benefit and Cost Determinations Are Conclusory and Not Based on Facts*

This rulemaking fails to engage in the requisite cost benefit analysis and instead asserts conclusory statements overstating the purported benefits and downplaying any potential costs. Beyond the dereliction of duty to conduct this analysis, the conclusions are even more troubling because they are so clearly contradicted by prior findings by the EPA and state authorities in relation to whisky aging warehouses. Accordingly, we respectfully submit that this rulemaking is arbitrary and capricious, and urge the EPA, at the very least, to retain the general fugitive exemption at 40 CFR § 52.21(i)(c)(vii) so modifications that would not be "major modifications of a major source, *but for the inclusion of fugitive emissions,"* would continue to be excluded from NSR.

The proposal makes conclusory and unsupported environmental and health impact claims. The proposed rulemaking asks stakeholders to assume that any exposure to a fugitive emission has a health risk, and that environmental justice communities are particularly vulnerable to fugitive emissions. Further, the rulemaking assumes that the NSR review will reduce health and environmental risks, and that these benefits will be far greater than the costs of NSR review and permitting– without any attempt to assess the potential benefits and without any analysis of the actual cost of obtaining offsets, costs to major source operators to conduct a PSD analysis of fugitive emissions that EPA has determined cannot be reasonably captured and calculated, the cost of likely product delays, and all other related costs. The rulemaking does not provide any analysis of these benefits or costs, which it should. Without such an analysis, the rulemaking should be withdrawn because it is arbitrary and capricious.

The proposal also minimizes potential industry impact and costs. The rulemaking contends that "major modifications" will rarely if ever occur at "unlisted" sources of fugitive emissions because they are not major modifications, however this claim is belied by the agency's expertise on how manufacturing plants operate and the clear assembled knowledge that listed and unlisted industry categories operate at the same plants. For example, there are a significant number of policies on EPA's website devoted to the definition of "source" that involve equipment or processes in an industry category that are co-located with other processes from other SIC codes and, even more frequently, have "support" equipment from other source categories that are located on the same or adjacent property "that are under common ownership or control" (e.g., industrial steam boilers, grinding operations, NSPS dryers in listed coating operations, glass making operations). EPA offers no evidence to support its assurances that many major sources are unlikely to be affected by including "fugitive

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emissions" from unlisted categories in making "major source determinations," and the attempt to downplay the reach without any guarantees provides little comfort.

Further, the Notice suggests that because "fugitive emissions" are determined on a case-by-case basis, this is too confusing for local regulators and/or EPA to apply.[47] The proposed solution to simply count "all emissions" in making NSR "major modification" determinations solves for nothing, as those decisions would still be necessary to weigh on a case-by-case basis the feasibility and reasonableness of controls for fugitive emissions for major source determinations pursuant to CAA Section 302(j) listings. The CAA is readily acknowledged to be one of the most difficult of EPA's programs to implement and the agency proposes to make it even more difficult if this regulation is finalized.

IV. **Conclusion**

For all of the reasons outlined above, we respectfully submit that fugitive emissions from spirits aging warehouses should continue to be excluded from "major modification" determinations under the NSR program. We urge the Agency to not depart from the longstanding policies on fugitive emissions and to not repeal the 2008 Fugitives Rule for unlisted industries under 40 CFR § 52.21(b)(1)(iii)(a) or 40 CFR § 52.22(i)(3)(viii), which have applied broadly for decades to modifications of major sources that could be deemed a major source modification based solely on fugitive emissions. In the alternative, if EPA finds that it must generally repeal the 2008 rule and fugitives exemption, these policies should be narrowly retained for beverage alcohol aging warehouses, given the longstanding exemption for fugitive emissions in the industry, demonstrated inability to effectively capture fugitive emissions without impairing product quality, and minimal environmental impact of potentially capturing ethanol emissions from aging warehouses.

Requiring distillers to include fugitives in determining if physical changes to major sources are major modifications that would be subject to NSR Review and pollution controls would create great uncertainty and cause irreparable harm to the American distilled spirits industry. This proposal risks damage to product quality and global reputation of these products, as well as financially burdening the distilling community to such a degree that many may be forced to shutter and reduce staff—potentially damaging the very communities this proposal seeks to protect. As detailed above, there is a long history of EPA and state agencies exploring air pollution control devices for whisky or rum aging warehouses, resulting in findings that there are no reasonable controls that could be employed in a manner that would not have an adverse impact on the product quality.[48]

Further, the environmental benefits of capturing and controlling ethanol emissions from the natural aging process would be minimal—even if all the ethanol would be eliminated from the pollution controls—because of the minimal reactivity of the ethanol generally in the

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[47] *See id.* at 62,333.
[48] *See Supra* Section II.

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environment. The benefits of regulating fugitive emissions, particularly from the distilled spirits industry, are greatly outweighed by their costs and would impose a lethal risk to a time-honored, unique industry.

Once again, thank you for this opportunity to provide our views regarding this important proposal. Please do not hesitate to reach out with any questions.

Best regards,

Courtney Armour
Chief Legal Officer
Distilled Spirits Council of the United States

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Appendix A

1. April 1978; EPA, Cost and Engineering Study - Control of Volatile Organic Emissions from Whisky Warehousing

2. June 27, 1994; Kentucky Department of Environmental Protection Letter Regarding Aging Warehouse Fugitive Emissions Determination

3. August 19, 1994; EPA Region IV Letter Regarding Fugitives Emissions from Whisky Aging Warehouses

4. March 1997; "Emission Factor Documentation for AP-42 -- Distilled Spirits" (EPA Contract 68-D2-0159)

5. February 10, 1999; EPA Policy Memo, "Interpretation of the Definition of Fugitive Emissions in Parts 70 and 71"

6. October 23, 2000; EPA Letter to Senator Robert Smith Regarding RACT for Aging Warehouses

7. 2001; Maryland Department of the Environment Technical Support Document, "Control of Volatile Organic Compounds From Distilled Spirits Facilities – COMAR 26.11.19.29"

8. August 4, 2004; Indiana Office of Environmental Adjudication Findings of Fact, Conclusions of Law, and Final Order Regarding Aging Warehouse Fugitive Emissions

9. September 17, 2009; Final SJAPCD Final Draft Staff Report for Rule 4695

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April 1978

COST AND ENGINEERING STUDY - CONTROL OF VOLATILE ORGANIC EMISSIONS FROM WHISKEY WAREHOUSING

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

COST AND ENGINEERING STUDY - CONTROL OF VOLATILE ORGANIC EMISSIONS FROM WHISKEY WAREHOUSING

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UNITS AND CONVERSIONS

Listed below are abbreviations and conversion factors for the metric units in this report and definitions for non-standard units associated with whiskey production.

Metric Unit (Abbreviation)	Equivalent
1 meter (m)	= 39.37 inches = 3.28 feet
1 centimeter (cm)	= 10^{-2} meter = 2.54 inches
1 hectare (ha)	= 10^5 m^2 = 2.47 acres
1 kilogram (kg)	= 2.2 pounds
1 metric ton (MT)	= 1000 kilograms = 2200 pounds

Unit	Definition
proof gallon (pg)	one U.S. gallon of 231 cubic inches containing 50 percent by volume ethanol or any volume of liquid containing an equivalent amount of ethanol. A proof gallon thus contains 1.5 kilogram of ethanol.
proof	twice the volume percent ethanol in a liquid. The number of proof gallons in a gallon of liquid is the proof divided by 100.

1.0 INTRODUCTION

The Environmental Protection Agency is currently providing technical
assistance to the States and local jurisdictions on industries that emit
significant quantities of air pollutants in those areas of the country where
National Ambient Air Quality Standards are not being attained. This document
is related to one such industry, whiskey warehousing. It is a significant source of
volatile organic chemicals (VOC) in the area where the industry is concentrated,
Kentucky, Illinois, Indiana, and Tennessee.

1.1 EMISSION SOURCE DESCRIPTION

In producing whiskey, alcohol distilled from fermented grain is stored
in charred oak barrels for periods of four to eight years or more. During
this period, the alcohol absorbs, and reacts with, constituents in the
barrel wood and gains the distinctive taste and aroma of whiskey. This process
is known as aging or maturation. During the aging period, ethanol and water seep
through the barrel and evaporate into the air. Also when the barrels are emptied
to bottle the whiskey, ethanol and water remaining in the barrel wood evaporate
into the air. These last two phenomena are the major sources of VOC emissions in
whiskey production.

Based on changes in the proof and liquid volume of whiskey during aging,
an emission factor of 3.2 kg/barrel-yr. was computed. On the basis of production,
the emission factor is .2kg ethanol/kg produced. Based on an estimated 10,260,000

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barrels stored in Kentucky, Illinois, Indiana, and Tennessee, the total yearly emission of VOC from whiskey warehousing is 32,800 MT/yr for the four State areas.

1.2 CONTROL DEVICE DESCRIPTION

The method investigated for control of emissions both during aging and from barrel soakage after aging was carbon adsorption. Control of emissions during aging would involve closing the warehouse and ducting exhaust from the facility through a carbon adsorption unit. Control of barrel soakage losses would involve placing the empty barrels in a closed warehouse ducted to a carbon adsorption unit. These control methods are estimated to reduce emissions by 85 percent. The efficiency is limited by the need to design and operate the system in a manner that will not affect whiskey quality and by the physical difficulties in drying the saturated barrels.

The applicability of these control systems is determined by two factors:
1. the cost of systems and
2. the system's effect on whiskey quality.

The cost of the system for controlling losses during aging for three of the six cases studied is shown in Table 1-1. Also shown is the cost of controlling soakage losses by storing the empty barrels in a warehouse. As seen in the table, an important factor in the systems' cost is the credit for the recovered alcohol. The recovered alcohol can be redistilled to a product for which sufficient markets exist to use the amounts recovered; however, very few distillers have the equipment required for this redistillation. Thus, distillers would have to transport the recovered alcohol in crude form or install the necessary distillation equipment, options which significantly reduce the credit shown for the recovered alcohol.

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Table 1-1
CONTROL SYSTEM COSTS

	Aging Loss Control			Soakage Loss Control
Warehouse Size, Barrels	20,000	50,000	100,000	50,000
Annual Capital Costs	$9,960	$15,410	$31,700	$71,000
Annual Operating Costs	$11,980	$17,280	$26,010	$58,710
Annual Credit, Recovered Alcohol	$13,610	$54,440	$68,050	$55,150
Net Cost (Return)/yr	$8,330	$(21,750)	$(8,340)	$74,560
Cost/Final Proof Gallon	3.0¢	‑	‑	2.8¢

Two other cost problems are present in installing and operating the control systems, providing steam for regeneration of the carbon beds and providing sufficient air flow to dry the empty barrels. Whiskey warehousing facilities, especially those in rural areas, are spread over large areas and would require long lines to carry regeneration steam from boilers to the warehouses. The cost of such a distribution system has not been estimated and thus was not included in the cost calculations. In controlling barrel soakage losses, large flows of air are used to dry the barrels. Since carbon adsorption unit costs rise directly with air flow capacity, the flow rate is a critical parameter in the system's cost. Since such a system has never been installed, the flow rate required is not known precisely and could have been underestimated in this report.

Whiskey quality could be affected if the carbon adsorption system altered such warehouse conditions as temperature, humidity, and ventilation. These changes would affect the various physical and chemical processes involved in whiskey aging and evaporation, such as the diffusion of water and ethanol through the wood, the transfer of wood constituents into the whiskey, and the chemical reactions

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occurring in the wood and the whiskey. In the one full scale test of the control system, whiskey quality was in fact lowered and the test was discontinued. However, analysis of the test indicates that certain design and operating changes may have eliminated the whiskey quality problems.

The cost problems discussed above and the failure of the full scale test show that control of emissions from whiskey warehousing has not been demonstrated at this time. However, the control systems show a potential for breaking even or producing a profit, an unusual characteristic for a control system. Even without credit for recovered alcohol, the control system costs 7-10¢/proof gallon, which compares favorably to a production cost of $2.10/proof gallon. In addition, engineering analysis indicates that problems with whiskey quality can potentially be solved with proper design and operation. Thus, it appears possible that further work could demonstrate the feasibility of control. This work would include the following:

1. investigation of alternate carbon regeneration techniques, for example electric heating/vacuum regeneration

2. additional economic analysis. A low sensitivity of liquor demand to price changes and the large percentage of liquor prices made up by taxes may allow the costs of the control to be passed on even without credit for recovered alcohol.

3. additional testing of the control systems

4. scheduled tests to demonstrate an alternate aging system. This system is discussed in section 4.5.

This further work was not able to be completed at the publication date of this document.

2.0 WHISKEY WAREHOUSING AND AGING

The manufacture of whiskey involves two distinct steps - the production of unaged whiskey from cereal grains and the maturation of this whiskey by storage in charred white oak barrels.

In the production of unaged whiskey, grain is first milled, then cooked in water to solubilize the starches. The solubilized starches are then mixed with partially germinated grain. This step results in the starches being hydrolyzed to sugars by the enzymes in the germinated grain. The sugars are then fermented with yeast and the resulting mixture is distilled to produce unaged whiskey. The production of unaged whiskey is a source of only a small percent of the volatile organic chemicals emitted in whiskey manufacture. The emissions from this first step are described in Appendix A.

The unaged whiskey, colorless and pungent tasting, must be aged by storage in charred oak barrels to produce an alcoholic beverage with the traditional characteristics of whiskey. This step, whiskey aging, is the major source of emissions in whiskey manufacture and will be the principal focus of the report. This chapter will describe whiskey warehousing operations and the physical and chemical processes that occur as whiskey ages. Chapter 3 will present emission factors for whiskey warehousing and the basis of these emission factors, and Chapter 4 will describe possible emission controls and their advantages and disadvantages.

2.1 BARRELING AND WAREHOUSING

To produce an alcoholic beverage with the traditional qualities of whiskey, the unaged whiskey is stored in new, white oak barrels, whose head and staves have been charred. The barrels are normally constructed of 25 staves from 2 to 3 cm in thickness and charred for 30 to 50 seconds. The barrels typically hold 190 liters and are approximately 89 cm tall and 54 cm diameter at the head.

During aging, the barrels are stored in large warehouses. There are three types of warehouse design: brick and masonry rack design; metal clad, wood-frame rack design; and palletized design. Rack designs consist of multi-level lattice structures made of wood or metal, on which the barrels are tightly packed on their sides in long parallel rows and supported by beams at the ends of the barrels. In rack design warehouses, there are commonly three to six levels of barrels per floor and five to ten floors per warehouse. Brick rack designs have concrete floors, roof, and brick exteriors, with windows normally on each floor for ventilation. Metal clad rack designs have corrugated or sheet metal exterior and roof which are attached to the interior wood lattice. The wood lattice supports the barrels and provides the structural support for the warehouse. In contrast to brick and masonry warehouses, where the concrete floors block internal air circulation, metal clad warehouses are open internally with ventilation provided by windows or ventilators at the top and bottom of the structure. Palletized design warehouses are single story structures with barrels stored upright on pallets, with 15 barrels a pallet. Palletized designs require more land than rack designs, but reduce the labor required to handle the barrels.

The barrel capacity range of warehouses varies as a function of design: 40,000 to 100,000 for brick rack designs, 20,000 barrels or less for metal clad rack designs, and up to 35,000 for palletized designs. The absence of water sprinklers for fire protection in metal clad rack warehouses limits their size for insurance reasons.

The total barrel capacity of a typical warehousing operation ranges from 200,000 to 600,000 barrels. Brick warehouses are generally used in urban areas because of fire and building codes, and metal clad warehouses are generally used in rural areas. Metal clad warehouses are placed 60 meters or more apart for fire protection and thus a large storage facility with 30 warehouses will cover up to 450 hectares. Other smaller rural facilities may be dispersed because of hilly terrain or to place the warehouses in the optimum location for aging. A listing of barrels stored in Kentucky distilleries is presented in Appendix B.

2.2 MECHANISMS OF AGING

The main components of whiskey, ethanol and water, are relatively insignificant factors in its flavor intensity and palatability. The distinctive qualities of whiskey are due for the most part to the trace constituents, called "cogeners," present in the beverage. These substances are generated in part during fermentation, but the majority are added in the course of aging.

During aging these trace constituents are added to the whiskey by three mechanisms:[1]

1. extraction of organic substances from the wood and their transfer to the whiskey,

2. oxidation of the original substances and of the extracted wood material, and

3. reaction between various organic substances present in the liquid
to form new products.

The nature and changes in the concentration of these trace constituents are shown
in a comprehensive study of whiskey during maturation by Liebmann and Scherl
of Schenley Distillers.[2] Their study covered an 8 year period and included
analysis of 469 barrels. Table 2-1 presents the statistical design of the
major variables of the study and Table 2-2 lists the characteristics of whiskey
at various maturation times. The main changes in physical and chemical characteristics
of whiskey, occurring as a function of time are shown in Figure 2-1.

There are several points to note concerning changes in whiskey during
aging as observed in the Liebmann and Scherl study. The fixed acids, furfural,
solids, color, and tannins in whiskey are added entirely during aging. (The
small amounts present initially in tne whiskey sampled in the study were due to
the fact that some of the whiskey had been treated with oak chips before barreling.)
In contrast, there are significant quantities of esters and fusel oil and
lesser quantities of total acids and aldehydes present prior to aging. The
concentration changes for most constituents are essentially complete by three
years of aging; however, esters and solids continue to show significant increases
in concentration beyond that time. The increase in aldehydes, acids and esters,
oxidation and reaction products of alcohols, show the importance of chemical
reactions in aging. In examining the chemical changes it is important to note
that there are only rough relations between chemical analysis and quality,
i.e., taste and aroma of whiskey. It is necessary to rely on the human
senses of taste and smell to detect fine variations and thus evaluate the quality
of whiskey.

The precise sequence and interdependence of the mechanisms responsible
for aging are quite complex and not completely understood. However, the
following paragraphs describe in general the chemical and physical phenomena
responsible for aging. The description is purposely qualitative since the

Table 2-1. STATISTICAL DATA OF WHISKEY MATURATION STUDY BY LIEBMANN AND SCHERL [2]

Grain formula			Distillation			Treatment			Warehouse			Storage		
Type	No.	%	Type	No.	%	Type	No.	%	Type	No.	%	Location	No.	%
Bourbon			Singled	82	17	Untreated	255	54	Rack (wood)	219	47	Louisville, Ky.	128	27
60% corn 40% small grain	84	18	Doubled	387	83	Oak chip-treated	54	12	Concrete	250	53	Schenley, Pa.	114	24
75% corn 25% small grain	43	9		469	100	Nuchar-treated	160	34		469	100	Lexington, Ky.	64	14
80% corn 20% small grain	151	32					469	100				Lawrenceburg, Ind.	91	19
88% corn 12% small grain	112	24										Frankfort, Ky.	72	16
Rye 51% rye 49% other grains	79	17											469	100
	469	100												

Table 2-2. CHARACTERISTICS OF AMERICAN WHISKIES AT VARIOUS AGES [2]

Age Yr.	Mon.	Proof	Total Acids	Fixed Acids	Esters	Alde-hydes	Fur-fural	Fusel Oil	Solids	Color (Density)	Tan-nins	pH
	0	101.8	4.9	0.8	16.7	1.4	0.2	111	8.7	0.032	7	4.92
	3	101.4	20.4	3.7	17.2	2.1	1.2	123	44.1	0.155	12	4.62
	6	101.3	32.2	5.3	18.5	2.8	1.5	131	46.0	0.205	21	4.46
1		101.4	42.5	6.6	21.8	3.3	1.6	131	87.7	0.247	28	4.38
		102.0	53.4	8.3	26.8	4.1	1.7	132	111.1	0.292	35	4.34
2		103.1	58.1	8.0	31.1	4.4	1.8	132	127.6	0.308	39	4.29
		103.6	61.8	9.2	35.5	5.5	1.8	134	137.5	0.324	42	4.28
3		101.1	64.1	9.3	38.8	5.8	1.0	130	147.7	0.341	44	4.27
		104.7	65.8	8.3	41.8	6.0	1.0	135	152.7	0.372	47	4.26
4		105.2	67.8	9.4	44.7	6.1	1.8	137	157.7	0.360	48	4.26
		105.5	69.2	9.4	47.6	6.1	1.7	138	165.0	0.355	48	4.26
5		106.0	70.2	9.5	48.0	6.2	1.7		166.0	0.357	49	4.26
		106.7	72.0	9.5	51.0	6.3	1.8		173.0	0.368	49	4.26
6		107.0	71.6	9.6	55.0	6.5	1.8		174.2	0.303	49	4.20
		107.9	74.4	0.7	57.8	7.0	1.8		181.5	0.380	49	4.24
7		103.6	70.2	0.7	61.2	7.0	1.8		188.0	0.391	50	4.24
		103.9	70.4	0.7	62.0	7.0	1.9		198.8	0.393	50	4.23
8		103.3	81.9	9.7	64.8	7.0	2.0		198.9	0.413	50	4.22
									209.0	0.449	53	4.20

* All figures represent average values and are expressed as grams per 100 liters at 100 proof, except proof (expressed in degrees proof), color (expressed as density), and pH.
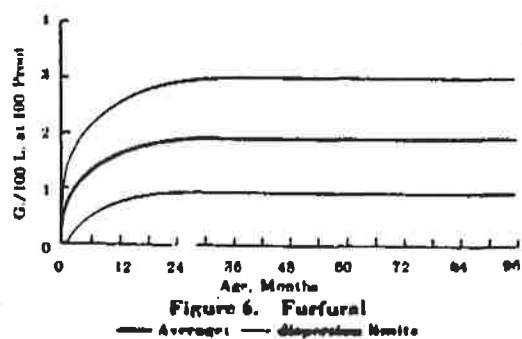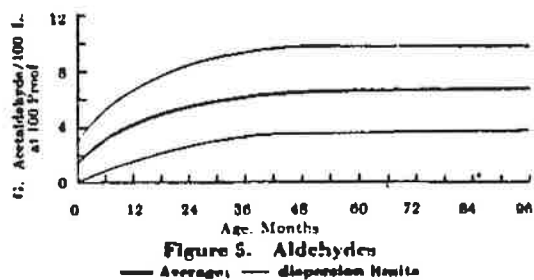
Figure 1. Proof
——— Average; ——— dispersion limits

Figure 2. Total Acids
——— Average; ——— dispersion limits

Figure 3. Fixed Acidity
——— Average; ——— dispersion limits

Figure 4. Esters
——— Average; ——— dispersion limits

Figure 5. Aldehydes
——— Average; ——— dispersion limits

Figure 6. Furfural
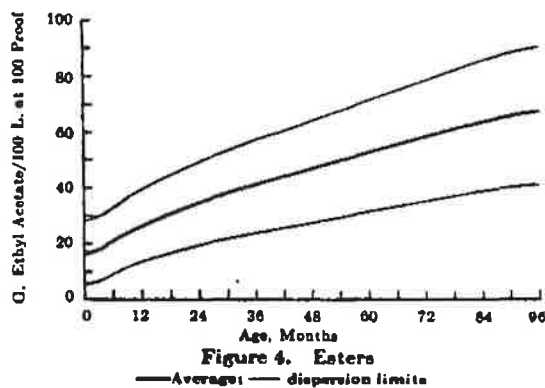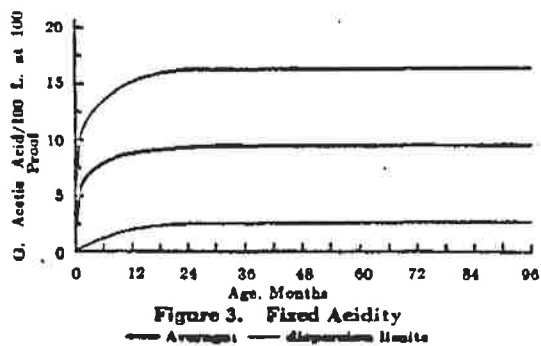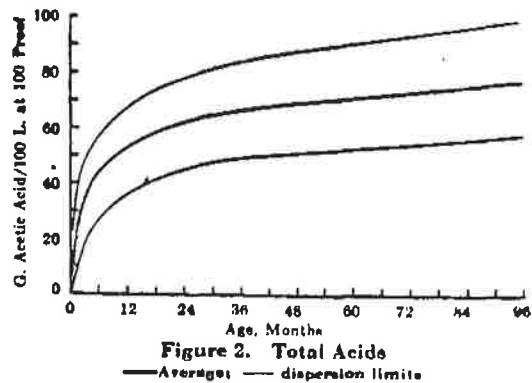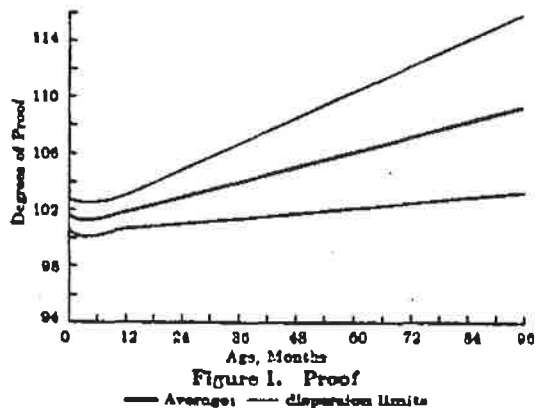——— Average; ——— dispersion limits

Figure 2-1. Effect of maturation on the physical and
chemical characteristics of whiskey,
Liebmann and Scherl study [2]

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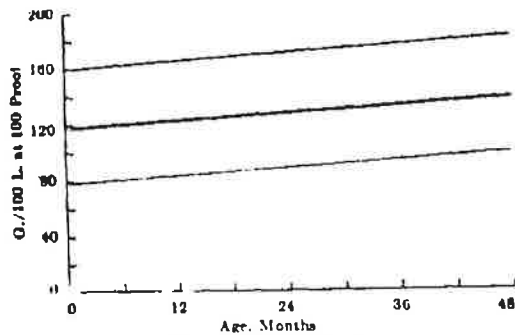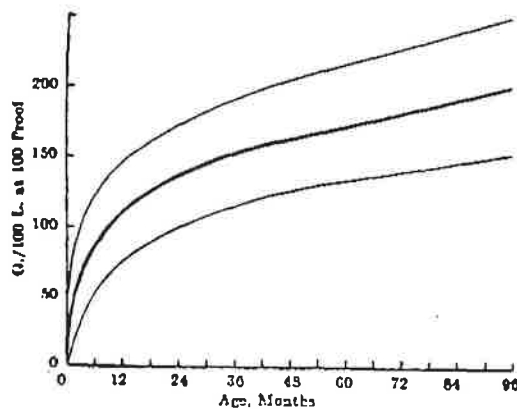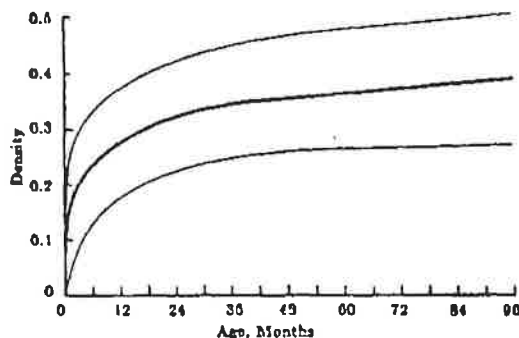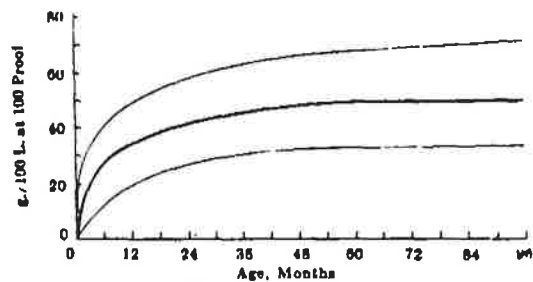
Figure 2-1. (cont.) Effect of maturation on the physical
and chemical characteristics of whiskey,
Liebmann and Scherl study[2]

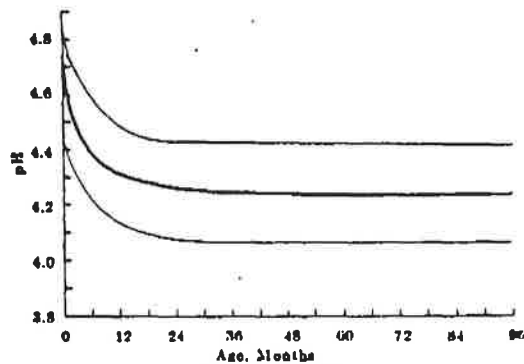exact rates of the phenomena and the sensitivity of these phenomena to changes in such variables as temperature and entry proof is not precisely known.

The aging process begins when the barrel is filled with whiskey and the charred wood becomes saturated with liquid. The liquid extracts from the charred wood partially oxidized organic substances in the char, the biologically formed organic substances in the uncharred wood, plus color and various solids. This material is transferred to the bulk liquid in the barrel by simple diffusion, by convection currents in the bulk liquid and by temperature cycling. Temperature cycling causes transfer of material in the following way. As the barrel heats up, the gas above the liquid increases in pressure and forces liquid into the barrel wood. When the barrel cools and the gas pressure drops, the liquid flows out of wood into the bulk liquid, carrying wood constituents with it. The materials transferred and originally in the wood react to form new compounds. These reactions occur on the surface of the wood, with the char acting as a catalyst, and in the bulk liquid. In addition, oxidation of chemical substances occurs as a result of the slow diffusion of air into the barrel liquid.

The rates of extraction, transfer, and reaction depend on temperature and the concentrations of various whiskey constituents. The effect of temperature is straightforward - higher temperatures increase the rates of extraction, transfer by diffusion, and reaction. Also, temperature changes cause convection currents in the liquid and pressure changes in the gas affecting transfer. The effect of concentration is more complex. The rate of extraction of various char and wood constituents will depend on the relative concentration of ethanol and water in the wood, since the constituents will exhibit differing solubilities in water vs. ethanol. The rate of extraction will also depend on the overall

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concentration of liquid in the wood. The rate of diffusion will depend on the difference of concentrations of constituents in the wood, liquid, and air around the barrel. The rates of reaction will increase or decrease with the concentration of constituents.

The equilibrium concentrations of the various whiskey components depend heavily on the air flow around the barrel. A large air flow will lower the concentration of water, ethanol, and trace constituents in the air and increase the concentration gradient between the air and the barrel wood. This will have a number of effects. First, the larger concentration gradient will cause water and ethanol to evaporate faster and the ethanol/water content of the barrel wood to drop. An example of this phenomena is that blotter strip whose end is stuck in water will be drier and water will evaporate faster with air blowing over it. The faster evaporating ethanol and water will draw more wood constituents out than normal, allowing less to travel inward to the bulk liquid. Also the lower liquid content of the wood will effect extraction. Finally, the larger concentration gradient for trace constiuents will cause these substances to evaporate to the air faster, again upsetting their inward transfer to the liquid. Figures 2-2 and 2-3 illustrate these various transfer mechanisms, and other aspects of aging.

2.3 WAREHOUSE OPERATION

The preceding discussion illustrates the importance of correctly controlling the barrel environment to produce a whiskey of a desired quality. Since each distiller desires to produce a whiskey with a quality distinctive to their brand, the various distillers control the barrel environment differently by operating their warehouses in different manners. However, it must be kept in mind that the effects on whiskey quality of such warehouse parameters as temperature, temperature cycling, humidity and ventilation are not precisely known.

EVAPORATION OF
ETHANOL & WATER THROUGH
CAPILLARY ACTION

PRESSURE
CHANGES
IN GAS

ATMOSPHERE   LIQUID

LIQUID SURFACE

LIQUID FORCED INTO
WOOD BY PRESSURE CHANGES

REACTIONS BETWEEN ETHANOL,
TRACE CONSTITUENTS IN THE WOOD,
LIQUID AND AIR. THESE REACTIONS
OCCUR IN THE LIQUID AND AT THE SURFACE
OF THE WOOD.

AIR
DIFFUSION

EVAPORATION
OF ETHANOL
& WATER THROUGH
BARREL WOOD

CHAR

CONVECTION CURRENTS MIXING
CONSTITUENTS INTO THE
BULK LIQUID

DIFFUSION OF WOOD

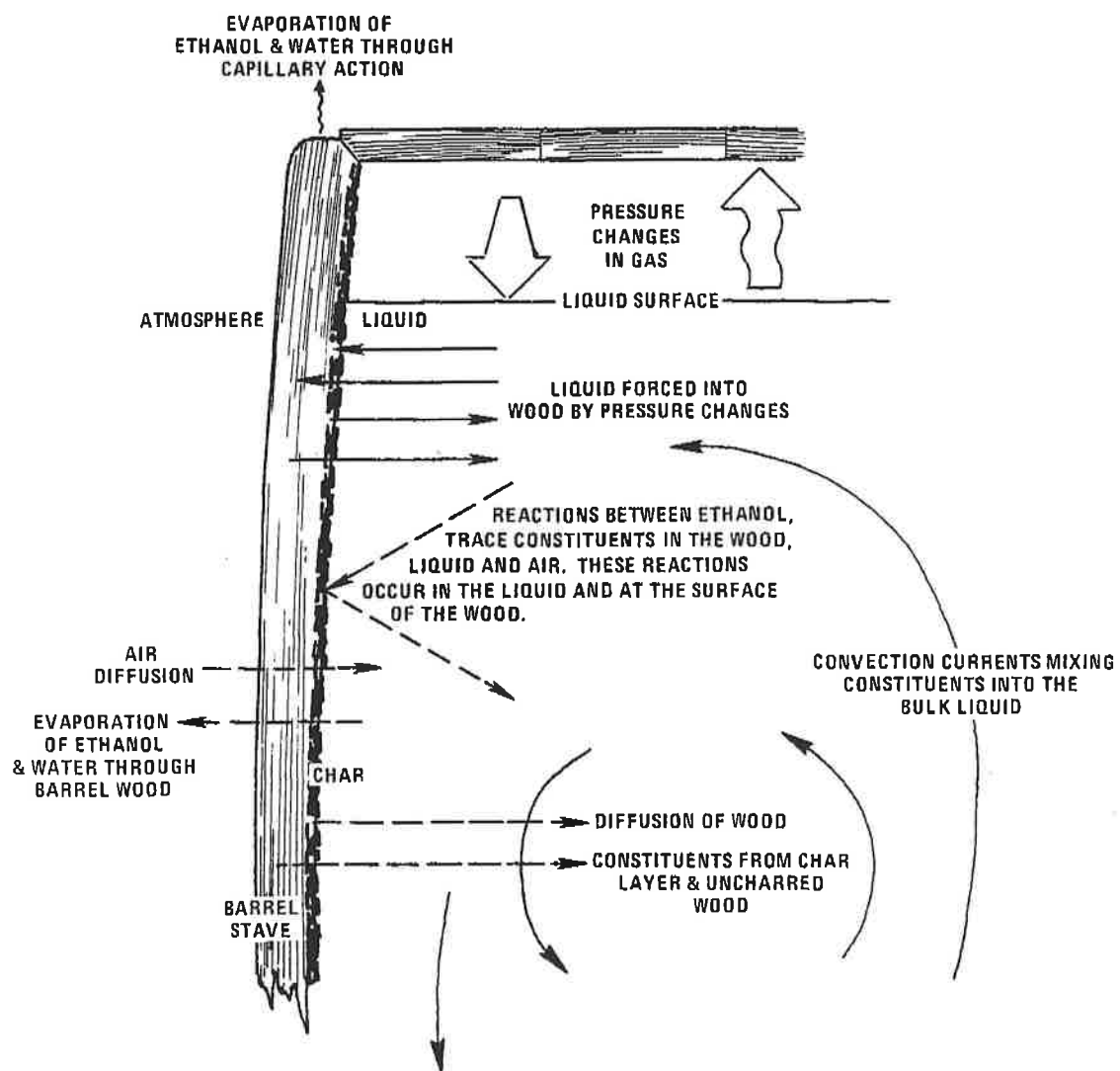CONSTITUENTS FROM CHAR
LAYER & UNCHARRED
WOOD

BARREL
STAVE

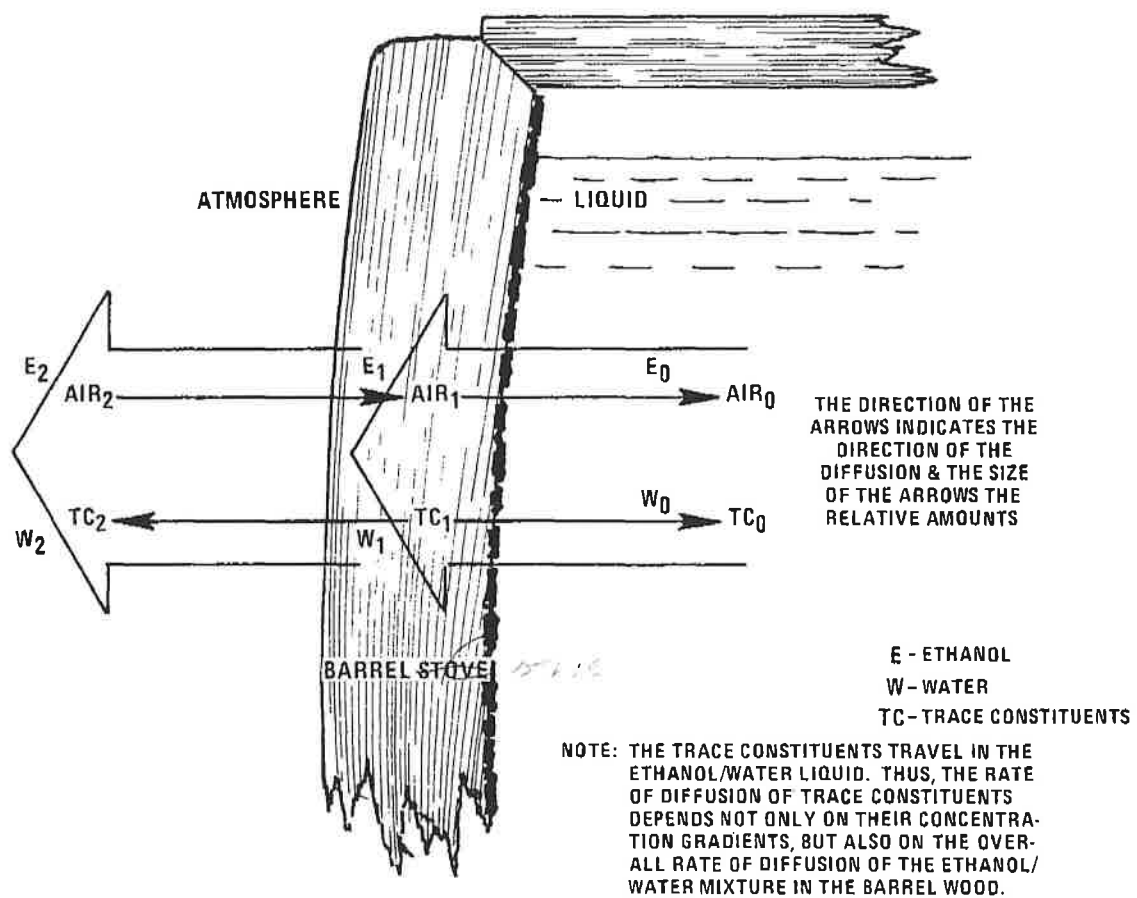Figure 2-2. Mechanisms of whiskey aging.

Figure 2-3. Diffusion through barrel staves in whiskey aging.

Thus, present methods of warehouse operation have not been developed by design and calculation; rather, each distiller's operation is for the most part the result of tradition and experience.

Other factors besides quality influence warehouse operation. These include the differing construction costs between metal clad and brick designs, the energy required if heating is used in the winter, the labor involved in moving barrels and opening and closing windows, the level of evaporative losses, and the savings in barrel costs if whiskey entry proof is increased.

The most important variation in warehouse operation is the type of warehouse: brick, metal clad or palletized. One aging/quality philosophy is that the best whiskey is produced when the barrel follows natural conditions during aging. Thus, metal clad warehouses are used since their exteriors are designed only to keep rain and snow from the barrels and provide no additional protection from the weather. However, the labor savings involved in palletized designs, construction costs and fire codes also influence the choice of warehouse type.

Another area where variations in practice occur is the type of ventilation provided for the solar heating effect. The large roof area of palletized designs and the poor insulation characteristics of metal clad designs allow relatively high rates of solar heat transfer through the roof and upper levels. If no natural or forced air circulation is provided, a hot, stagnant air mass develops in the upper area and a sizable temperature difference can develop between the top and bottom of the warehouse. This effect is commonly observed in metal clad warehouses during the summer, when temperatures of 120 to 140°F can develop in the top floor while temperatures at the bottom are only 65 to 70°F.

Various practices are followed with respect to this solar heating effect. Some distillers desire the elevated temperatures to achieve the type of aging they desire and thus close the bottom or top windows to create these high temperatures. Others provide for ventilation at the top and bottom of the warehouse to induce air flow and reduce the temperature difference. This is done not only to produce different temperatures for aging, but also to reduce the high evaporation losses at the elevated temperatures and to produce more uniform aging conditions in the warehouse. One distiller, in an effort to achieve complete uniformity of conditions and product, has sealed and insulated his metal clad houses and installed a central ventilation and heating system.

Variations in operating methods also exist among brick warehouses and between brick and metal clad houses. Brick houses have much better insulation characteristics, and thus do not experience the extreme temperature gradients in the warehouse during summer. Thus, whereas barrels stored in metal clad houses are rotated to average out the exposure temperature barrel rotation is not nearly as critical in brick warehouses. The insulating characteristics of brick warehouses also allow for heating in winter, whereas metal clads are allowed to follow the ambient temperature. In addition, among brick warehouses, different heating practices are used. Distillers not only maintain different temperatures in the winter, but also practice different cycling techniques. Some have only seasonal cycles, cooling in fall and warming in spring, while others intentionally increase and decrease the warehouse temperature several times in winter to produce the type of aging they desire. Variations between distillers also occur in the practice of summer ventilation. Some simply open the windows, while two locations have completely closed buildings and ventilate with fans.

Other more detailed variations undoubtedly exist. These include the time
of the year windows are closed or heating starting, the length of temperature
cycling, the frequency windows are open and shut, and the humidity characteristics
of the spot selected for the warehouse. All of these variations illustrate the
number of differing aging philosophies and traditions. The practices of
several distillers are shown on Table 2-3.[3-11]

Table 2-3
Warehousing Operations

ick & Masonry Design

Company	Heating in Winter	Open Windows in Summer	Forced Air Ventilation in Summer	Temperature Cycles	Temperature Summer	Winter
A	Yes	Yes	No	seasonal	Ambient	40°F
A, Bldg. E	Yes	No, no windows	Yes	seasonal	Ambient	40°F
B	Yes	No	Yes	several times in winter	Ambient	55°F
C	Yes	Yes	No	several times in winter	Ambient	40°F
D	No	Yes	No	seasonal	Ambient	Ambient

etal Clad

Company	Heating in Winter	Windows open in summer Bottom	Top	Barrel Rotation	Temperature – summer Top	Bottom
E	No	Yes	Yes	every 2 years	95°F	85°F
F	No	No	Yes	every 2 years	120°F	-
present	No	Yes	Yes	Not stated	Not Stated	
previously	No	No	Yes	Not stated	120°F	65°F
H	No	Yes	No	New barrels started at top and moved down	elevated	70°F
I		The warehouses have been sealed and insulated and a central heating/ ventilation system installed			temperature cycling in winter; in summer forced air ventilation used to keep the ΔT to a minimum	

2.4 REFERENCES

1. Liebmann, A. J., and B. Scherl. Changes in Whiskey While Maturing. Industrial and Engineering Chemistry. 41:534-543, 1949.

2. Reference 1

3. Trip Report by Terry Briggs, Pedco, Cincinnati, Ohio on a visit to Jim Beam Distillery, Clermont County, Kentucky, April 7, 1977.

4. Trip Report by Terry Briggs, Pedco, Cincinnati, Ohio on a visit to Schenley Distillery, Louisville, Kentucky, April 7, 1977.

5. Trip Report by Terry Briggs, Pedco, Cincinnati, Ohio on a visit to Barton Distillery, Bardstown, Kentucky, April 7, 1977.

6. Trip Report by Terry Briggs, Pedco, Cincinnati, Ohio on a visit to Seagrams, Inc., Lawrenceburg, Indiana, March 30, 1977.

7. Trip Report by Terry Briggs, Pedco, Cincinnati, Ohio on a visit to Seagrams, Inc., Louisville, Kentucky, March 30, 1977.

8. Trip Report by Terry Briggs, Pedco, Cincinnati, Ohio on a visit to Brown-Foreman, Louisville, Kentucky, April 8, 1977.

9. Trip Report by Terry Briggs, Pedco, Cincinnati, Ohio, on a visit to Heaven Hill Distillery, Bardstown, Kentucky, April 7, 1977.

10. Telephone conversation between Mr. T. W. Samuels, Jr. President, Maker's Mark Distillery, Inc., Louisville, Kentucky and David C. Mascone, U. S. EPA, September 19, 1977.

11. Telephone conversation between Mr. David C. Mascone, U. S. EPA and Bill Padgett, Austin Nichols, Lawrenceburg, Kentucky, January 19, 1978.

3.0 VOLATILE ORGANIC EMISSIONS FROM WHISKEY WAREHOUSING

This chapter will describe the volatile organic emissions from whiskey warehousing, develop an emission factor for these emissions and present an estimated national emission inventory.

3.1 EMISSION SOURCE DESCRIPTION

The two sources of ethanol in whiskey warehousing are evaporation from the barrel wood during storage and evaporation from the saturated wood after the barrel is emptied. These emission sources are described below.

The first emission, evaporation during storage, occurs when liquid diffuses through the barrel staves and heads via the wood pores or travels by capillary action to the ends of the barrel staves. The liquid evaporated is both water and ethanol, with minor amounts of trace constituents. As discussed in Chapter 2.0, this ability of the barrel to "breath", i.e. allow liquid to evaporate and air to enter, is important to aging. Attempts made to age whiskey in sealed containers and thus prevent losses have proven unsuccessful since little aging occurred.

The rate of evaporation during aging is not constant. During the first six months to a year, the evaporation rate is low, since the wood starts dry and must become saturated before evaporation occurs. After saturation, the evaporation rate is greatest but decreases as the evaporation lowers the liquid level in the barrel. The lower liquid level decreases the surface area of the liquid in contact with the wood and thus the surface area subject to evaporation.

The second emission, evaporation after barrel emptying, occurs when the saturated barrels are stored after emptying. The amount and location of these emissions depend on the use that the distillers find for the barrels. A significant fraction are stored outside for lengthy periods during which much of the alcohol evaporates. Even if further use is found for the barrels, the bound alcohol will still evaporate if the barrels are stored long enough before reuse. Potential end uses for used barrels are aging Scotch, Canadian whiskies and American light whiskies, and as fuel or for decorative purposes. Federal law prohibits the use of used barrels in bourbon and American blended whiskey.

3.2 WHISKEY WAREHOUSING EMISSION FACTORS

Two sources of data are available to develop emissions factors for whiskey warehousing - aggregate loss data from IRS publications and individual loss data from specific distillers.

3.2.1 Emission Factors from IRS Data

The aggregate loss data from IRS publications are presented in Table 3-1.[1,2] Shown on this table are data on whiskey withdrawals, losses and stocks for 1974, 1975, and 1976, along with emission factors calculated from this data. Withdrawals represent whiskey removed from storage for comsumption. Losses represent the difference between the original and withdrawn amounts, i.e. that amount of whiskey lost due to evaporation and barrel soakage, plus theft, spills, etc. Average stocks represent an average of the amount of whiskey held in storage for that year and the previous five.

Three emission factors were developed from this data. Emission Factor I represents the fraction of whiskey production lost and equals .2 proof gallons lost for each proof gallon whiskey produced. This factor was computed by dividing

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Table 3-1. LOSSES, WITHDRAWALS, AND STOCKS OF WHISKEY FOR THE U.S.

Column	1	2	3	4	5	6	7	8
	Year	Withdrawals	Losses	Withdrawals + Losses	Emission Factor I [1]	Average Stocks [2]	Emission Factor II [3]	Emission Factor III [4]
	1976	134.8	33.7	168.5	.200	870.6	.039	3.2
	1975	136.9	36.0	172.9	.208	910.0	.039	3.2
	1974	138.1	33.9	172.0	.197	935.7	.036	3.0

[1] Computed by dividing column 3 by column 4, represents pg lost/pg whiskey produced.
[2] Represents the average of the stocks of whiskey in storage for the previous 6 years.
[3] Computed by dividing column 3 by column 6, represents (pg lost/year)/pg whiskey in storage.
[4] Computed by multiplying column 7 by 55 pg/barrel and 1.5 kg/pg lost, represents kg ethanol lost/barrel-yr.

Table 3-2. BARREL SOAKAGE LOSSES

Source	Barrel Soakage kg liquid	Barrel Soakage lbs liquid	Aging Time, years	Best Fit Equation	No. of years	kg lost-equation
Brown-Foreman	7.3	16	5		5	8.1
Boruff & Rittschof	10.3	22.6	8	kg liquid soakage (i.e. water + ethanol)	8	10.0
Gallagher, et. al.	8.6	19	5		5	8.1
Schenley	5.5	12	1		1	5.4
	11.4	25	10	=.67(aging time,yrs) +4.7 for years 1 & greater	10	11.4

total losses by total production (losses plus withdrawals). Emission Factor
II represents the loss rate based on stored whiskey and equals .038 proof
gallons lost for each proof gallon in storage each year. This factor was
computed by dividing total losses by average stocks. The number of proof
gallons in stock was taken to be the average of the number of proof gallons
in stock for that year and the previous five. The 6-year average stock
was used since losses recorded for a given year represent losses on barrels
emptied that year. These losses actually occurred not only during that year,
but in previous years while the barrel was in storage. Six years is an
approximation of the period of barrel storage - some of the losses for a
given year come from barrels stored eight years and more, whereas some
stored six years ago have already been emptied for four year old whiskey.
Emission Factor III represents a weight loss rate per barrel per year and equals
3.2 kg ethanol/per barrel each year. This factor was computed by multiplying
Emission Factor II by 55 proof gallons per barrel and 1.5 kg ethanol per
proof gallon. It is important to note that the above figures include losses
for both evaporation during storage and soaking into the barrel.

3.2.2 Emission Factors from Individual Distiller Data

The loss rate data from individual distillers and from experiments cover
two areas, barrel soakage losses and evaporation losses during storage. These
are discussed below.

The data available on barrel soakage losses are presented in Table 3-2.[3,4,5,6]
The table shows the available data on total liquid soakage vs. aging time,
plus a best fit equation for this data. The table indicates a rapid saturation
of the barrel during the first year, followed by a constant, but slow, increase
in weight during subsequent years. It should be noted that the data are for
liquid soakage, i.e., both water and ethanol. Work by Boruff and Rittschof[7] indicates
that the proof of the liquid in the barrel wood is approximately the same as

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the proof of the stored whiskey; this permits a conversion from kg liquid to kg ethanol. Thus, a typical barrel storing 120 proof whiskey emptied after four years contains 3.8 kg of ethanol in the saturated wood.

The data from experiments and individual distillers on evaporation during storage are shown on Table 3-3.[7-13] The cumulative loss represents the total ethanol loss due to evaporation during the aging time shown. The annualized loss rate expresses this total at a constant yearly loss rate and was computed by dividing the cumulative loss by the aging time. Table 3-3 also shows a best fit equation for annualized losses for aging times of four years or more.

Annualized loss rates vs. aging time, as computed from the data and equation in Table 3-3, are shown on Table 3-4. Also shown on Table 3-4 are computed cumulative loss and computed incremental loss. Cumulative loss was calculated by multiplying the aging time by the annualized loss rates from the best fit equation. Incremental loss was computed by subtracting the computed cumulative loss for two successive years. This later number represents the additional evaporative loss during the given year of aging.

Figure 3-1 shows graphically the data on annualized loss rate from Table 3-3 and the computed annualized and incremental loss rates from Table 3-4. The graph clearly shows the wide variation in evaporative loss between distillers. These variations can be explained qualitatively by variations between distillers in such warehouse parameters as temperature, ventilation patters and temperature cycling. However, because of the large number of conditions that affect evaporation and the limited knowledge on the precise effects of the conditions on the rate of evaporation, no attempt was made to statistically relate warehouse conditions to evaporative loss.

Figure 3-1 also shows the variation in the incremental loss rate during aging, with the rate increasing during the first two years and decreasing in

Table 3-3. EVAPORATIVE LOSSES DURING STORAGE

Source No.[a]	Aging Time Years	Cumulative Loss kg ethanol/barrel	Annualized loss[b] kg ethanol/barrel-yr	Best fit Equation-Annualized Loss
Gallagher, et. al.	1	2.35	2.35	
Gallagher, et. al.	2	6.59	3.30	
A	4	9.52	2.38	For years 4 & greater
C	4	15.60	3.90	
E	4	9.32	2.33	Annualized Loss (kg ethanol/barrel-yr)
F	5	14.45	2.89	$= -.101$(aging Time, yrs) $+3.38$
C	6	20.88	3.48	
Boruff & Rittschof	8	17.76	2.22	
F	9	18.81	2.09	
I	10	26.70	2.67	

[a]Letters indicate data from individual distillers; Letters refer back to same distillers as Table 2-3
[b]Annualized losses assuming equal loss each year.

Table 3-4. COMPUTED ANNUALIZED, CUMULATIVE & INCREMENTAL LOSSES

Aging Time Years	Annualized Loss kg/barrel-yr[a]	Cumulative Loss kg/barrel[b]	Incremental Loss kg/barrel-yr[c]
1	X 2.35	2.35 Y_1	2.35
2	x 3.30	6.60 Y_2	4.25
3	3.10	9.30 Y_3	2.70
4	2.98	11.92 Y_4	2.62
5	2.88	14.40 Y_5	2.48
6	2.78	16.68	2.28
7	2.67	18.69	2.01
8	2.57	20.56	1.87
9	2.47	22.23	1.67
10	2.37	23.70	1.47

[a]Years 1 & 2 are taken from Gallagher, et. al.; years 3 & greater from the best fit equation, Table 3-3.
[b]Annualized loss times aging time.
[c]Difference between cumulative loss for successive years.
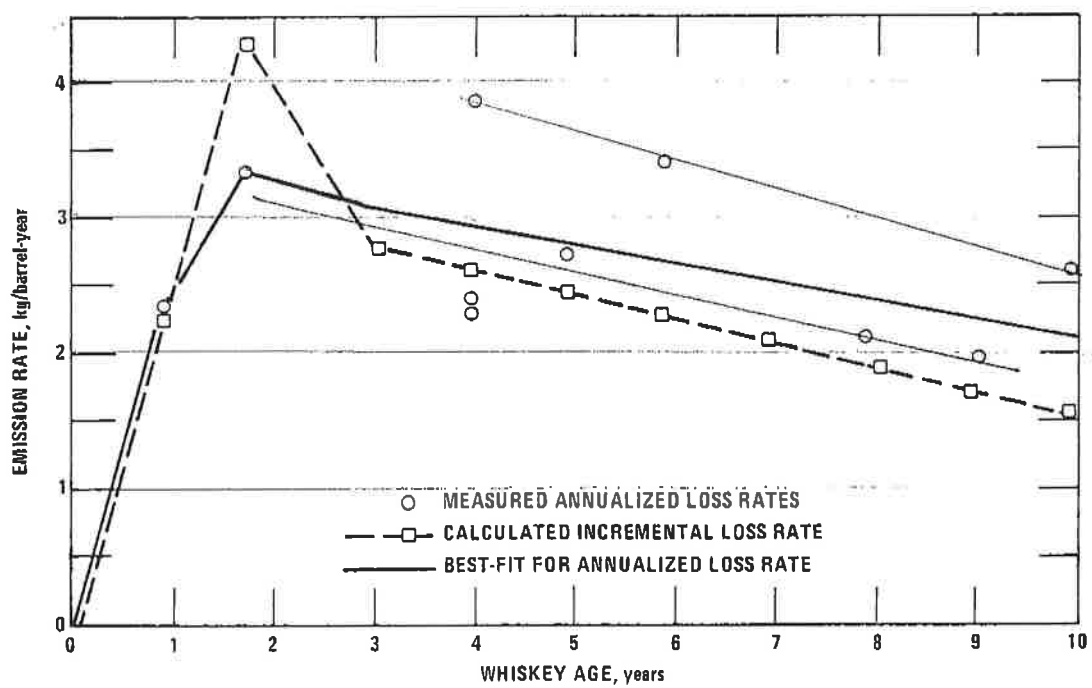
Figure 3-1. Emission rate relationships in the whiskey aging process.

subsequent years. This is in agreement with the theory discussed early.
This variation in the incremental loss rate means that the age mix of the
barrels in storage will affect the emission rate. Since barrels of different
age have different evaporative loss rates, the total emissions will be
determined by the fraction of barrels at each age.

Three different barrel age distributions were used to calculated emission
factors: (1) the age distribution of bonded whiskey in Kentucky at the end of
1975;[14] (2) an age distribution based on fluctuating market from year to year;
and (3) the age distribution based on distillers producing mainly four year
old whiskey.   Table 3-5 presents the barrel age distribution for the three
cases and the respective emission factors of 2.55 kg/barrel-yr for case one,
2.74 kg/barrel-yr for case two, and 2.89 kg/barrel-yr for case three. These
emission factors were calculated by multiplying the fraction of the barrels at
a given age by the incremental loss for that age in Table 3-5. The four distillers
producing primarily four and six year old whiskey used in case three are
Jim Beam, Clermont, Kentucky; Jim Beam, Beam, Kentucky; Brown-Foreman, Louisville,
Kentucky; and Fleischmann, Owensboro, Kentucky.[15]

The above emission factors represent evaporative losses during storage only.
To determine overall emission factors, losses due to barrel soakage must be
included. This loss is computed by assuming that the number of barrels emptied
in a year equals the number of barrels one year old, and that the average barrel
has a soakage equivalent to a five year old barrel. This figure is 4.2 kg ethanol/
barrel. The overall emission factor is therefore:

Aging + Soakage = Total Emissions

```
  case one) 2.55 + 4.2 (.112) = 3.02
  case two) 2.74 + 4.2 (.172) = 3.46      kg/barrel-yr
case three) 2.89 + 4.2 (.181) = 3.65
```

In the preceding discussion, the variations in evaporative loss rate
during aging were averaged together to develop a single emission factor.

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Table 3-5. WAREHOUSE BARREL AGE DISTRIBUTION

(1) Whiskey by Various Periods of Production Remaining in
     Bonded Warehouses in Kentucky as of Dec. 31, 1975.

Age	Barrels in bond in Kentucky	Fraction by year	
0-1	685,600	0.112	
1-2	657,600	0.107	
2-3	813,800	0.132	
3-4	943,400	0.153	Average barrel loss
4-5	868,700	0.141	2.55 kg/barrel-year
5-6	821,000	0.134	
6-7	761,900	0.124	
7-8	349,600	0.057	
9+	247,200	0.040	
	6,148,600	1.000	

(2) Barrel Age Distribution Assuming a Uniform Year-to-Year
     Consumption Rate (100 bbl/yr basis)

Age	% Used (end of year)	Total by year	Fraction in warehouse by year	
0-1		100	0.172	
1-2		100	0.172	
2-3		100	0.172	
3-4	35	100	0.172	Average barrel loss
4-5	20	65	0.112	2.74 kg/barrel-year
5-6	15	45	0.079	
6-7		30	0.052	
7-8	20	30	0.052	
9+	10	10	0.017	
		580	1.000	

(3) 4 to 6 yr Whiskey Production

Age	Beam Beam, Ky.	Beam Clermont, Ky.	Brown-Forman Louisville, Ky.	Fleishmann Owensboro, Ky.	Overall age distribution
0-1	58948	60743	97000	30901	0.181
1-2	64014	74076	104437	38568	0.205
2-3	98247	78559	41840	35413	0.185
3-4	91239	84464	63371	36411	0.201
4-5	17572	24102	60514	30412	0.097
5-6	1110	31594	37320	35963	0.077
6-7	303	14981	4321	5412	0.018
7-8	2122	25207	2783	208	0.022
9+	5698	12069	858		0.014
					1.000

Average barrel loss = 2.74 kg/barrel-year

This single emission factor was then used together with data on barrel age distributions to compute several emission factors. A second method of developing emission factors from the loss data reported by individual distillers is to group the data into higher and lower measured annualized loss rates. As noted previously in Chapter 3, large variations in measured annualized loss rate result from differing warehouse operations. The analysis of the loss rates by dividing them into higher and lower values will provide two emission factors characterizing the spread of emissions caused by differences in warehouse operations. Examination of Figure 3-1 shows that the bottom four and top three data points for measured annualized loss fit into two convenient groups. Analysis of these groups results in emission factors of 2.3 and 3.6 kg/barrel-yr for evaporative loss during aging.

It should be noted that the above analysis was not performed rigorously. A rigorous analysis would require that the annualized loss data be converted to incremental losses, and then the incremental loss applied to barrel age distributions. This was not done because it was felt that three data points (four in the lower value case) were not sufficient for these conversions to remain statistically meaningful. Thus, the emission factors of 2.3 and 3.6 kg/barrel-yr were determined by drawing lines, lines through the bottom four and top three points for measured annualized losses (Figure 3-1) and the loss rate at year five were taken to be the appropriate emission factor.

All the emission factors for volatile organic chemicals from whiskey warehousing are summarized in Table 3-6. The emission factors based on the variations in warehouse operations are used in designing and costing the control system. The emission factors developed from the barrel age distributions, along with Emission Factor III from the IRS data, are used to develop emission inventories. Finally, Emission Factor I from the IRS data is used to relate

Table 3-6. SUMMARY OF EMISSION FACTORS
WHISKEY WAREHOUSING

Source	Figure	Description
IRS Publication	.20 proof gallons lost/proof gallons produced*	represents fraction of production lost
	.038 proof gallons lost/proof gallons storage-yr*	represents fraction of storage lost per year
	3.2 kg ethanol/barrel-yr*	represents amount of ethanol lost per barrel in storage per year
Individual Distiller Data & Experiments	3.8 kg ethanol soakage/barrel	represents amount of ethanol lost per barrel due to soakage into wood. The figure is for a barrel stored 4 years.
	3.02,3.46,3.65 kg ethanol/barrel-year	represents amount of ethanol lost due to both evaporation during storage and soakage for various barrel age distributions
	2.3,3.6 kg ethanol/barrel-yr	represents the range of ethanol loss durir storage caused by differing methods of warehouse operation; does not include soakage loss

*These figures include all types of loss - evaporation during storage, soakage into the barrel, plus leakage, theft,etc.

whiskey sales to markets in the discussion of reuse of the recovered alcohol.
The reason for using each emission factor for the uses described above is given
with the calculations involving that emission factor.

3.3 EMISSION INVENTORY

Total emission estimates are developed for three areas: (1) typical size
distilleries, (2) States; and (3) nationwide.

Two representative facilities were chosen to develop emission totals for
typical size distilleries: (1) a large 400,000 barrel facility producing primarily
four year whiskies and (2) a smaller 50,000 barrel facility producing whiskies
up to eight years and older. To compute the emission total for the 400,000
barrel facility the emission factor used is that of case three in on page 3-9
This emission factor is used since the barrel age distribution for case three
and for the 400,000 barrel facility are both based on producing four year old
whiskies. For the 50,000 barrel facility, the emission factor used is that
of case one on page 3-9. This emission factor is used since the Kentucky
barrel age distribution approximates those of distillers producing eight year
and older whiskies. The emission totals for the large distillery is 400,000
barrels x 3.65 kg/barrel-yr = 1460 MT/yr and for the large distillery 50,000
barrels x 3.02 kg/barrel-yr = 151 MT/yr.

Total emission estimates will be developed for five States - Kentucky,
Indiana, Illinois, Tennessee, and Maryland. Table 3-7 shows the number of
barrels stored in each State[16] and the total emission estimate. The emission
factor used was 3.2 kg/barrel year, based on the aggregate loss data from IRS
publications. This emission factor was used since, being based on the widest

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Table 3-7. TOTAL EMISSION ESTIMATE BY STATE

State	No. of Barrels in Storage June, 1976, Thousands	Total Emissions (MT/yr)
Kentucky	6130	19,620
Illinois	1290	4,130
Indiana	2260	7,240
Maryland	640	2,050
Tennessee	580	1,780

data base, it was most likely to have correctly averaged the variation in barrel emission rates that occur between warehouses.

The national emission total estimate is 38,170 MT/yr, based on 11.9 million barrels stored in June, 1976. The five States above represent 91 percent of the estimated emissions.

3.4 REFERENCES

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3. Trip Report by Terry Briggs, Pedco, Cincinnati, Ohio on a visit to Brown-Foreman, Louisville, Kentucky, April 8, 1977.

4. Gallagher, M., P. Kolachov, and H. F. Willkie. WHiskey Losses During Aging. Industry and Engineering Chemistry 34:992-995, 1942.

5. Boruff, C. S., and L. A. Rittschof. Effects of Barreling Proof on the Aging of American Whiskies. Agricultural and Food Chemistry. 7(9): 630-633, 1959.

6. Trip Report by Terry Briggs, Pedco, Cincinnati, Ohio on a visit to Schenley Distillery, Louisville, Kentucky, April 7, 1977.

7. Reference 4.

8. Reference 5.

9. Reference 6.

10. Trip Report by Terry Briggs, Pedco, Cincinnati, Ohio on a visit to Seagrams, Inc., Lawrenceburg, Indiana, March 30, 1977.

11. Letter from Dr. Alan T. Thomas, Brown-Forman Distillers, Louisville, Kentucky to Pedco, Cincinnati, Ohio, April 19, 1977.

12. Trip Report by Terry Briggs, Pedco, Cincinnati, Ohio on a visit to Jim Beam Distillery, Clermont County, Kentucky, April 7, 1977.

13. Trip Report by Terry Briggs, Pedco, Cincinnati, Ohio on a visit to Barton Distillery, Bardstown, Kentucky, April 7, 1977.

14. Liberty National Bank and Trust Co. of Louisville, Kentucky. Distilled Spirits in Bonded Warehouses in Kentucky on December 31, 1975. Bulletin 114, Louisville, Kentucky.

15. Reference 14.

16. Reference 2.

4.0 WAREHOUSE EMISSION CONTROL

Two methods for reduction of warehouse emissions were investigated:
1) carbon adsorption (CA) and 2) an alternate aging system. The second method of
control is in early development and will require a number of years for testing.
However, the system's potential for large reduction in aging costs makes it
attractive as a control method, given successful testing.

4.1 CARBON ADSORPTION - SYSTEM DESCRIPTION

Controlling warehouse emissions by carbon adsorption would involve
closing the warehouse and ducting the interior to a carbon adsorption unit.
For brick warehouses, this would involve shutting most windows, doors, and
ventilators, leaving some open for intake air, and running ductwork along the
exterior of the building to the various floors. In some metal clad warehouses,
extra work may be required to close gaps between metal sheets, and between the
roof and the sides. However, most metal clad warehouses are tight enough in
construction that closing windows, doors, and ventilators would be sufficient.
The areas of sheet metal overlap would not need to be sealed since these areas
would provide the infiltration required to balance the air removed by the CA unit.

The CA unit itself would be a skid-mounted package system containing two
beds, fans, switching mechanisms and control, condenser/decanter, and internal
piping for steam and air flow. The unit would run on a two cycle system with
one bed adsorbing as the second was regenerated and cooled.

4.2 CARBON ADSORPTION - COST ANALYSIS

In determining the costs of the carbon adsorption system, a number of assumptions were made. These assumptions are listed in the sample calculation shown later. Several of the major assumptions are discussed below.

First, two warehouse ethanol concentrations, 750 and 1500 ppm, were chosen. The ethanol concentration must be stipulated since this parameter establishes the flow rate of the CA unit. The 750 ppm level complies with the OSHA exposure standard of 1000 ppm, 8 hour time-weighted average; the 1500 ppm level reflects the concentration believed to be required for proper whiskey aging. (A more complete discussion of the OSHA standard, whiskey quality and other impacts of the control system is presented later.) Second, a range of installed costs vs. adsorber size was chosen based on the evaluation of a number of sources.[1,2,3,4] The costs used ($20/scfm for units less than 4000 scfm, $14/scfm for units greater than 15,000 scfm, and $17 for those in between) represent figures in the middle of the range presented by the sources. Third, a value of $0.53/proof gallon of recovered alcohol was chosen. This was based on the current price of 190 proof alcohol of $1.12/gallon[5] (or $0.59/proof gallon) discounted $0.04/proof gallon for transportation and $0.02/proof gallon for the utilities required for redistillation of the recovered alcohol. Fourth, 85 percent recovery efficiency and an adsorber flow capacity of one and a half times that based on a warehouse mass balance were chosen. The 85 percent recovery allows for the maximum ethanol losses through openings in the warehouse, through design of CA unit to achieve proper aging and during redistillation. It is expected that greater efficiencies could be attained in many cases. The 1.5 times the mass balance design allows for variations in the adsorber air flow rate required for proper whiskey aging and for recovery of the higher emissions in summer caused by warmer temperatures. Finally, two barrel emission rates,

2.3 and 3.6 kg/barrel-year, were chosen to examine the effect the variations in emission rates caused by differing warehouse operations have on system design and cost. A sample calculation follows.

Sample Calculation

1) Assumptions

- barrel emission rate of either 2.3 or 3.6 kg/barrel-yr. (Approximately 5.0 or 8.0 lbs/barrel-yr) and warehouse ethanol concentration of either 750 or 1500 ppm.

- total installed costs (TIC)

$20/scfm for units $\leq$ 4000 scfm
$17/scfm 4000 scfm $\leq$ unit $\leq$ 15,000 scfm
$14/scfm for units $\geq$ 15,000 scfm

- other costs

Annualized capital costs	= 15 percent TIC
Taxes, insurance, etc	= 4 percent TIC
Steam	= 17¢/100 lbs
Carbon	= $1.00/lb
Electricity	= 3¢/kw·hr
Maintenance	= .1 hr/hr operation at $10/hr

- design will be based on yearly operation, with an overall 85 percent recovery, with the actual unit at 1.5x the calculated flow rate

- bed design parameters - two foot bed depth, operating velocity at 75 fpm, 7 in. H_2O pressure drop, bed length 3 times bed width, 7 year bed life

- recovery parameters - bed capacity at 7 lbs ethanol/100 lbs carbon, 3 lbs steam/ 1b ethanol recovered, $0.53/pg ethanol recovered

2) Calculations

Example - 50,000 barrel warehouse, 750 ppm, 3.64 kg/barrel-yr (8.0 lbs/barrel-yr)

- Mass Balance - the system must be designed so that the emission rate of ethanol matches the removal rate by the CA unit.

emission rate = (No. of barrels)(lbs/barrel-year)
removal rate = (scfm)ppm/10^6 (1/360)lb-mole/ft^3 X
 (46 lb/lb-mole)5.18(10)^5 min/yr

or (No. of barrels)(lbs/barrel-yr) = scfm(ppm)6.62 (10)$^{-2}$
thus (50,000)8 = scfm (750)6.62(10)$^{-2}$
 scfm = 8060

- Total Installed Costs

Unit size = 1.5(8060) = 12,090 scfm
$17/scfm (12,090) = $205,530
Annualized .15($205,530) = $30,829

- Other Costs

  the amount of ethanol recovered =
  .85(50,000)8 =
  340,000 lbs whiskey/yr

  steam requirement =
  $340,000(3) = 1.02(10)^6$ lbs steam/yr
  $1.02(10)^6$ $.17/100 lbs steam =
  $1734/yr

  taxes, insurance, etc. =
  .04 (TIC) = .04 ($205,530)
  $8221

  electricity =
  (7 in H_2O) 249 pascals/in H_2O = 1160 joules/m^3 Air
  $5.18(10)^5$ min/yr (scfm) 1/35.3 (m^3/ft^3) = $1.47(10)^4$ (scfm) m^3

  using a 60 percent efficiency factor and $3.6(10)^6$ joules/kw·hr
  (7.06/.6) $.03/kw·hr (8060) =
  $2850/yr

  maintenance and labor
  .1 hr/hr operation x $10/hr =
  8640 (.1) $10 = $8640

- Bed Design

  scfm/linear velocity = surface area (SA)
  SA = 12,090/75 = 161 ft^2

  L = 3W; SA = LW; SA = $3W^2$; W =$\sqrt{SA/3}$
  W = $\sqrt{161/3}$ = 7.3 ft
  L = 3W = 22ft

  Bed volume = 2 ft(SA) = 322
  322 (30 lbs/ft^3) = 9660 lbs/carbon
  9660/7 yr ($1/lb) = $1380/yr Replacement carbon

  Cycle time (assume 50 percent of ethanol removed from bed each cycle)
  340,000 lbs ethanol-yr/8640 = 39.4 lbs/hr
  9660 lbs carbon (.07 lbs ethanol/lb carbon).5 removal efficiency =
    338 lbs recovered/cycle
  338/39.3 = 8.5 hours

- Value of Recovered Alcohol

  3.31 lbs/pg
  340,000/3.31 = 102,720 pg/yr
  102,720 (.53) = $54,400/yr

A comparison of six recovery system design cases is presented in Table 4-1. The cases cover three warehouse sizes and two emission rate/warehouse ethanol concentration combinations. The warehouse capacities chosen were 20,000, 50,000, and 100,000 barrels and represent typical sizes for existing metal clad and brick units. The emission rate/warehouse ethanol concentrations chosen were 8 lb/yr-barrel, 1500 ppm, and 5 lb/yr-barrel 750 ppm. These cases represent the highest and lowest net return rates, respectively.

The cost analysis as presented in Table 4-1 indicates that the control system is financially feasible. Four of the six design cases offer net returns, the remaining cases small net costs. When these net costs are calculated on a per original proof gallon basis, aged 4 years, the cost is 0.52¢/proof gallon for Case A and 3.0¢/proof gallon for Case C. An average total cost for the six cases (costs without credit for recovered product) is 7¢/original proof gallon, aged 4 years. These figures compare to a $2.10/original proof gallon production cost for aged whiskey.[6]

The cost analysis in Table 4-1 does not include expenditures for steam production facilities or steam lines. Facilities without steam heating of warehouses (this includes most facilities with metal clad warehouses) would require lines, in some cases up to 750 meters, to transfer steam from the production plant to the warehouses. In addition, one or two smaller facilities would be require steam boilers in addition to steam lines. No calculations were made of these extra costs, but they would be significant.

4.3 CARBON ADSORPTION - FEASIBILITY

In addition to cost, several other considerations affect the applicability of carbon adsorption to control of VOC emissions from whiskey warehouses. These considerations are the system's effect on whiskey quality, the ability to reuse the recovered alcohol and OSHA standards.

Table 4-1

Recovery System Costs

	Case	A	B	C	D	E	F
No. of Barrels		50,000	50,000	20,000	20,000	100,000	100,000
Warehouse ethanol conc.,		750	1,500	750	1,500	750	1,500
Emission rate, lbs/yr-barrel		5	8	5	8	5	8
Actual SCFM		5,040	4,030	2,010	1,610	10,070	8,060
Design, 1.5 Actual		7,560	6,045	3,020	2,420	15,100	12,080
Total Installed Costs (TIC)		$128,520	$102,760	$60,420	$48,340	$211,400	$205,360
Annualized TIC		$ 19,280	$ 15,410	$ 9,960	$ 7,250	$ 31,700	$ 30,800
Whiskey recovered, lbs/yr		212,500	340,000	85,000	136,000	425,000	680,000
Steam, 10^6 lbs/yr		.637	1.02	.255	.408	1.27	2.04
Steam, $/yr		$ 1,080	$ 1,730	$ 430	$ 690	$ 2,160	$ 3,470
Electricity, $/yr		$ 1,780	$ 1,420	$ 710	$ 570	$ 5,330	$ 2,850
Tax, etc., $/yr		$ 5,140	$ 4,110	$ 2,420	$ 1,930	$ 8,460	$ 8,210
Maintenance, $/yr		$ 8,640	$ 8,640	$ 8,640	$ 8,640	$ 8,640	$ 8,640
SA, ft.^{2}		100	80	40	32	200	160
Length, ft.		17	16	4	10	25	22
Width, ft.		5.8	5.2	3.7	3.3	8.2	7.3
Cycle Time, hrs.		8.5	4.3	8.5	4.3	8.5	4.3
Carbon, lbs.		12,000	9,600	4,800	3,840	23,000	19,200
Carbin, $/yr		$ 1,720	$ 1,380	$ 680	$ 540	$ 3,420	$ 2,740
Proof gallon whiskey/yr		64,200	102,720	25,680	41,090	128,400	205,540
Whiskey value, $/yr		$ 34,030	$ 54,440	$ 13,610	$ 21,780	$ 68,050	$ 108,940
Total Annual Costs, $		$ 37,640	$ 32,690	$ 21,940	$ 19,620	$ 59,710	$ 56,710
New Cost (Return)		$ 3,610	$(21,750)	$ 8,330	$(2,160)	$ (8,340)	$(52,230)
Cost/4 yr. Proof gal.		.52¢	--	3.0¢	--	--	--

4.3.1 Effect on Whiskey Quality

Whiskey quality is a critical factor in the marketability of whiskey and in the distinction between the various brands. Alterations in whiskey quality, i.e., taste and aroma, are a serious concern to distillers since such alterations could affect consumer acceptance of the product and thus reduce sales.

As discussed in Chapter 2, the taste and aroma qualities of whiskey are largely a product of whiskey aging. Whiskey aging, in turn, is a complex process composed of a number of interrelated chemical and physical mechanisms. A CA system, with the potential for changing such warehouse conditions as temperature, ventilation patterns, and humidity, could affect these aging mechanisms and thus alter quality.

The installation and operation of a CA system could affect whiskey quality in a number of ways. First, the increased ventilation provided by a carbon adsorber could lower the concentration of ethanol, water and trace constituents in the air around the barrel. This would increase the rates of evaporation of these constituents and alter the liquid content of the wood, upsetting the equilibrium concentrations in the wood, liquid and air and potentially affecting quality.

Proper design of the CA system could eliminate this effect. If the flow rate of the CA unit was adjusted so that the removal rate of air matched that provided by natural ventilation, the ethanol, humidity and trace constituent levels in the warehouse would remain unchanged. Since the CA unit is removing air, and thus the components in the air, at the same rate as natural ventilation, both natural ventilation and the CA system would provide for the same build up of these components in the warehouse.

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However, other effects could occur. A CA unit provides a continuous flow of air across the barrels; natural ventilation would be intermittent. Thus, a CA unit would provide constant concentrations around the barrels, whereas natural ventilation would allow the buildup of stagnant layers. These stagnant layers would be removed occasionally by the natural ventilation, producing a stop-start effect in which evaporation occurs quickly after a draft and slows as the stagnant layer builds up. Another effect would be the lowering of the temperature differentials between the top and bottom of the warehouse. A CA would take air from several floors within the warehouse and either recirculate this air or draw in new air This mixing and ventilation would remove the hot, stagnant air at the top of the warehouse, reducing the temperature on these floors.

It appears that proper design could also eliminate these effects. The proper stagnation periods and concentration levels could be maintained around the barrel by adjusting the air flow rate and sequencing the ventilation. In such a system, only two or three of the warehouse floors would be ducted to the carbon adsorber at one time. Time-controlled dampers in the air exhaust lines would sequence which floors received ventilation. During the period a floor was off ventilation, the stagnation layers could build up. Elevated temperatures at the top of the warehouse could be achieved by using very low or no ventilation on the lower floors. Alternately, the system could be designed to draw air upward through the warehouse. The air drawn in at the bottom would be heated by the sun during the period it rose upward. Thus it appears that the proper combination of air flow rates, ventilation patterns, air recirculation, and other design parameters could reproduce most warehouse conditions. In addition, it appears that this could be achieved in most cases with straight-forward engineering and at moderate cost.

However, proper design is not the only criterion; it is important to know what conditions to reproduce. Given the complex nature of whiskey aging, it is difficult to state precisely what are the conditions for proper aging and thus how to design the CA system. This is especially true considering the number of different brands of whiskey. Development of the system through experimentation is also difficult. A minimum of 2 years is required to notice quality changes in aging whiskey and 4 to 8 years to make a complete assessment. Potentially, 2 or 3 four to eight year aging cycles could be required to adjust the CA system to eliminate whiskey quality problems. Thus, the CA system's affect on whiskey quality is indeterminate. It would appear possible to design a system to reproduce the desired conditions but not possible to state with precision what these conditions are.

4.3.2 Re-use of Recovered Alcohol

Important to the costs of the CA system is the ability to re-use the recovered ethanol. This ability depends on two factors, the feasibility and costs of converting the recovered ethanol to a product suitable for use and the availability of markets for this converted product.

There are no market barriers to the re-use of the recovered alcohol, once it has been converted to grain neutral spirits. Though tax regulations prohibit its use in whiskies, the grain neutral spirits could be used in vodka and gin, or denatured for chemical use. Consumption figures[7,8] for both these indicate that sufficient markets exist to absorb the recovered product. If ethanol losses amount to 25 percent of the sales of American blended and straight whiskies,* this would provide 28×10^6 wine gallons/year or (assuming 100 proof

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*Emission Factor II from the IRS data is .2 pg lost/pg produced. To calculate an emission factor based on consumption, the losses must be subtracted from production to arrive at a consumption figure. The loss rate on consumption is thus .2/(1-.2) = .25

whiskey) 15×10^6 190 proof gallons/year. The use of ethanol for gin and vodka (assuming 100 proof for these products) is 53×10^6 190 proof gallons/year. Thus, the available market, gin, vodka, and industrial use, is 253×10^6 190 proof gallons/year (See Table 4-2). The recovered ethanol represents 11 percent of this market.

The conversion of the recovered ethanol to grain neutral spirits presents no technical problems. The recovered alcohol is of sufficient quality for distillation to grain spirits and the equipment and procedures to perform this distillation are known to the industry. However, few distillers actually have the installed capacity to produce grain neutral spirits; only one in Kentucky has such a capacity.[9] Thus, most distillers would be required to ship the recovered alcohol to a location with distillation capacity or install the capacity themselves. Both options present additional costs. The recovered alcohol would be at approximately 50 proof before redistillation, and in such a dilute form, would cost 19 cents/proof gallon to transport by tank truck.[10,11] The costs of installing and operating distillation equipment to produce grain neutral spirits were not calculated but would be considerable.

4.3.3 OSHA Standards, Insurance, Energy, and Secondary Environmental Impact

An important consideration in applying carbon adsorption to whiskey warehouses is the effect the control device will have on safety and worker health. Closing the warehouse to install a CA unit could increase the concentration of ethanol inside the warehouse, potentially violating OSHA standards and increasing insurance risks.

The OSHA standard for ethanol is 1000 ppm, time-weighted-average for 8 hours. Several of the proposed design cases are based on 1500 ppm ethanol in the warehouse, an apparent violation of the OSHA standard. However, several factors should be considered. First, the OSHA standard is a time-weighted

TABLE 4-2

Distilled Liquor Sales

$(10)^6$ wine gallons/yr

	1975	1973
Vodka	65.0	54.0
Gin	36.2	35.3
	101.2	89.3
Cordials	23.8	20.6
Rum	14.4	13.4
Bottled Cocktails	7.0	5.0
Imp. Whiskey	95.3	91.9
Other	19.4	17.3
	159.9	148.2
Blended Am. Whiskey	46.6	53.5
Straight & Bonded Whiskey	64.1	66.2
	110.7	119.7
TOTAL	371.8	357.2

Industrial Ethanol Use

$(10)^6$ gallons 190 proof/yr

1975	210
1976	200
1980	220

Ethanol Market Pattern

Percent

Chemical Manufacture	44
Solvent	46
Export	10

average with no short term maximum exposure limit. Thus, the OSHA standard would not be violated if a worker spent only part of his time in the warehouse and the remaining time outside or in other parts of the distilling complex. Thus, a 1500 ppm ethanol concentration would not restrict entry. The OSHA standard may affect labor practices since workers could not remain in the warehouse all day.

Secondly, as the discussion of whiskey quality indicates, the CA system would of necessity have to be operated to reproduce existing conditions and practices. The 1500 ppm design case was chosen to represent ethanol concentration presently used in aging. Thus, the installation of a CA system would present no additional problems for worker health compared to present methods of operation.

Contacts with an insurance company indicated that no additional insurance on the warehouse is required.[12] In addition, as discussed above, the operation of a CA system should not increase ethanol levels in the warehouse over existing levels.

Another important consideration in control device evaluation is energy and secondary environmental impact. In recovering ethanol and converting it to a usable product, the main areas of energy consumption are the steam used in regeneration of the carbon and in redistilling. Assuming that a one still system can adequately purify the recovered alcohol, the energy usage for regeneration is calculated to be 6.6×10^6 joules/kg ethanol recovered and for redistillation 7.9×10^6 joules/kg ethanol recovered. The energy for redistillation would be required even without the control system since the recovered alcohol would be replacing alcohol presently produced. By comparison, a distiller in his normal production operations (cooking grain, heating warehouses, operating other stills) uses an estimated 80×10^6 joules/kg ethanol recovered. In addition, the energy value of the ethylene required in production of synthetic ethanol is calculated to be 33×10^6 joules/kg ethanol. Thus, the proposed control system could potentially save energy.

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The main secondary environmental impact of the control system is the disposal of the waste water from distilling the recovered alcohol to grain neutral spirits. The amount of waste water produced in this manner would be 4 liters/kg ethanol recovered. By comparison, using a figure of 143 liters water/bushel grain in producing whiskey and assuming 95 of these liters become waste water, an estimated 61 liters waste water/kg ethanol recovered is produced by the normal operation of a distiller. Existing methods of waste water disposal at distillers should be able to handle this extra load.

4.4 CARBON ADSORPTION - WAREHOUSE TESTS

Between 1960 and 1968, a major distiller operated a carbon adsorption system on a whiskey warehouse at one of their facilities. A second distiller, National Distillers and Chemical Corporation, also installed a carbon adsorption system in the early 1950's to develop background data for a patent. However, the National test was conducted on only one warehouse floor, for one year, diverting a very small fraction of the exhaust air through a laboratory size carbon adsorber. Thus, the only full-scale test of the proposed control system is the one run from 1960 to 1968.

Table 4-3 lists the important data from the full scale test. Several points should be noted. First, the recovery efficiency and the proof of the recovered alcohol are both lower than the values used in the design calculations. Second, the carbon adsorber increased the rates of evaporation from the barrel and adversely affected quality. This last effect, the alteration of whiskey quality, was one of the principal reasons the test was stopped.

The full scale test, as run, does not demonstrate that a carbon absorption unit can be successfully applied to whiskey warehousing. At a recovery proof of 30, the transportation cost for the recovered alcohol is

Table 4-3. CARBON ADSORPTION SYSTEM DATA
FULL SCALE TEST, 1960-1968

Adsorber Design & Operating Parameters

Warehouse Size/Type:	97,500 Barrels/Brick & Concrete
Barrel Emission Rate:	5.25 lb/barrel-yr
Recovery Efficiency:	74 percent (5 yr. average)
Recovery Proof:	30.5

Operating Procedures & Conditions

Experiment One (1960-1964)	Year 1 & 2	Year 3	Year 4 & 5
Ventilation Rate	Normal	Reduced	Normal
Recirculation	Yes	Yes	No
Humidity	Elevated	Elevated	Normal
Proof	Decreased	Decreased	Stabilized
Whiskey Quality	-	Sour, wet wood characted	Improved to satisfactory

Experiment Two (1965-1968)	All years

Ventilation Rate:	Normal	Proof:	Normal
Recirculation:	No	Quality:	Poor all years
Humidity:	Normal		

Chronology: The changes in year 3 of experiment one were made to reduce the elevated humidity and temperature in the experimental warehouse. This proved unsuccessful and due to this and continued problems with whiskey quality, changes were made in year 4. The second experiment was run since the number of changes that were made in the first experiment made it unreliable as a data source.

Other Effects:

Evaporation: During both experiments, the rate of evaporation from the barrels increased. During the first experiment, the increase was .3 percent/yr (3.2 percent/yr. vs. 2.9 percent/yr normal) and during the second experiment, the increase was .4 percent/yr higher (3.3 percent/yr vs. 2.9 percent/yr normal).

Recovery: During the first two years of experiment one, when the adsorber exhaust was recirculated to the warehouse, the recovery rates were 83.3 and 93.3 percent compared to the 74 percent overall recovery for all five years.

32¢/proof gallon; this amount must be subtracted from the value of the recovered alcohol since the distiller would be required to absorb this cost. The recovery rate is 10 percent lower, and the steam usage higher (at 30 proof, the steam rate is 7 kg/kg) than the figures used in the design calculations, again adding costs. Finally, the whiskey lost due to the excess evaporation would need to be reproduced at $2.10/proof gallon aged. Though some of this is recovered by the carbon adsorption system (75 percent in the full scale test study), the recovery value is much lower. The effect of these factors on the recovery system cost is shown in Table 4-4. Thus, the factors in the test result in a net loss for the system. However, the net loss is 4.8¢/proof gallon aged, compared to $2.10 production costs. Therefore, the increased costs shown in the test, though significant, do not by themselves make the system infeasible.

The more critical problem was the system's demonstrated adverse effect on whiskey quality. In the full scale test, 360 barrels (180 in the second experiment) were filled with a quality approved lot of whiskey and split equally between the experimental warehouse (the warehouse with the CA unit) and a control warehouse (a warehouse operated normally). Whiskey quality tests were run yearly on samples from both sets of barrels; the samples were evaluated by taste test panel in a procedure similar to the method by which the actual product is tested. The results are shown in Table 4-3. The quality was poor into year three of experiment one; subsequent changes in the recovery system corrected this poor quality in year four and five. A second experiment was conducted to verify these results; however, the quality was poor in all years. The acceptable quality of years four and five in experiment one seems to have occurred because the poor quality of the previous years was being "undone." Normally, aging would not start with whiskey which had an inferior quality that needed to be corrected.

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Table 4-4. COST CALCULATIONS
FULL SCALE TEST

Design Parameters:

No. of barrels: 100,000
Emission Rate: 5.25 lbs/barrel-yr
Ethanol Concentration: 1500 ppm (assumed)
Excess loss: .35 percent yr (average of
two experiments) or .35/2.9 =
.12, fractional increase in
emission rate
Recovery: 75 percent
Steam Rate: 7 lbs steam/lb ethanol recovered

System Parameters:

Adsorber size calculated: 5290 scfm
Adsorber size, 1.5 x calculated: 7930 scfm
Ethanol lost: $5.88(10)^5$ lbs/yr
Ethanol recovered: $4.41(10)^5$ lbs/yr,
$1.33(10)^5$ proof gallons/yr
Steam: $3.09(10)^6$ lbs/yr
Carbon: 12,720 lbs

Costs:

Annual Capital Cost	$20,220
Taxes, Ins., etc.	5,390
Electricity	2,800
Steam	5,250
Maintenance	8,640
Carbon	1,820
	44,120
Credit for recovered ethanol, $.21/pg (includes transportation)	-27,930

Net cost
$16,190/yr
$64,760 for 4 years

Excess Evaporation
.12(100,000)(5.25)4 =
252,000 lbs, 76,130 proof
gallons at $2.10/proof gallon
$159,980

Total Cost
$224,720 for four years

Cost per Proof Gallon

55 proof gallons/
barrel orignally
100,000 barrels   5,500,000 proof gallons
minus evaporation   - 532,000
minus soakage   - 250,000
                          4,718,000 final proof gallons

Cost/final proof gallon
$225(10)^3/4.72(10)^6 = 4.8¢/proof gallon

It appears that certain changes in the design and operation of the CA system during the test could have eliminated problems encountered. First, the low recovery rate experienced was apparently due to the inadequate size of the adsorber unit. During each cycle, it is hypothesized that the bed became saturated and breakthrough occurred. Alcohol laden air thus passed through the adsorber to the atmosphere with no recovery occurring. The higher recoveries experienced during the first two years were apparently due to the recycling of the adsorber exhaust stream to the warehouse. Thus, when breakthrough occurred, the unrecovered alcohol was recirculated back into the warehouse and no loss to the atmosphere occurred. This unrecovered alcohol was eventually captured because, as it was recirculated back to the warehouse, the ethanol concentration in the warehouse increased. This increased concentration would increase the capacity of the adsorber unit, resulting in the eventual recovery of the alcohol. Confirmation of this hypothesis would require, among other things knowledge, of the adsorber bed capacity at the concentration, temperature and humidity of the warehouse air. This information is not available.

The deterioration of whiskey quality in the test study was apparently caused by three factors: higher humidity, lower ethanol concentrations, and continuous ventilation. The elevated humidity existed in the first three years during the time the adsorber exhaust was recirculated. Since the CA unit did not remove water, the recirculation of the adsorber exhaust resulted in the accumulation in the warehouse of the water evaporating from the barrels. The lower ethanol levels resulted from the continuous removal of organics from the warehouse by the CA unit. Though natural ventilation would also remove ethanol, the CA unit provided continuous air removal. In contrast, natural ventilation would be intermittent, removing ethanol only occasionally. In fact, during nights, weekends and winter, there may be no ventilation in warehouses since during those periods the windows and doors are sometimes

closed. In addition to continuous ventilation lowering the ethanol concentration, continuous ventilation also upset the stagnant air layers that develop around the barrel in natural ventilation. As discussed in Chapter 2.0, the removal of these stagnant layers replaces the stop-start diffusion pattern that normally occurs with natural ventilation.

The manner in which these factors affected quality is not clear. However, the altered concentrations of ethanol and water around the barrel and the continuous ventilation probably altered the concentrations, and cycles in concentrations, of substances in the barrel wood and bulk whiskey. The rates at which the mechanisms responsible for aging - extraction and solubilizing of wood constituents, diffusion of these constituents into the bulk liquid, chemical reactions between the various substances and transport of air into the bulk liquid - occur depend on these concentrations. Thus altering these concentrations alters the rate at which the aging mechanisms proceed, altering whiskey quality.

Various modifications in the test may have alleviated the whiskey quality problems. These modifications would have been to operate the system intermittently and to recirculate the adsorber exhaust part of the time. Intermittent operation could have been accomplished by sequencing the floors that receive ventilation, as described in section 4.3.1. Another option would have been to shut off the CA system during periods when the warehouse windows and doors would have been closed under normal operation. Such a method of operation would have allowed for stagnation periods, permitted the accumulation of ethanol to the proper levels required for aging, and reduced or eliminated excess ethanol evaporation. Partial recirculation could have eliminated the problem of both low and excessive humidity. This could have been accomplished by occassionally routing the adsorber exhaust to the warehouse. The amount of partial recirculation would be determined by the humidity level in the warehouse; the adsorber would be

exhausted outside when the humidity became too high. Another variation of
partial recirculation could occur in winter, when high air circulation
rates may have been required for forced air heating. During this period, the
adsorber could have been partially bypassed, with this by-pass stream being
recirculated. This would allow for sufficient air movement for heating, without
exhausting ethanol laden air to outside and without upsetting aging by
removing the ethanol from the larger air streams required for heating.

4.5 ALTERNATE SYSTEM OF AGING

A novel system of whiskey aging is under development in which maturation takes
place not in charred oak barrels but in closed stainless steel vessels lined with
straight charred staves.[13] This system is of interest due to its potential
for large savings in aging costs and for almost complete elimination of aging
losses. Its applicability to whiskey aging and control of warehousing emissions
will depend on the system's ability to produce whiskey of acceptable quality.

The central component of the system is a cylindrical stainless steel vessel
approximately 5 meters in diameter and 7 meters high, holding approximately 100,000
liters of liquid. Inside the vessel, straight charred oak staves are held in
the whiskey by arms extending radially from a shaft at the center of the vessel.
The staves are arranged so that air spaces created between them are manifolded
together to the central shaft holding the arms, and from there to vacuum, pressure
and condensing equipment. The central shaft can be designed to rotate to move
the staves through the whiskey. The vacuum equipment pulls vapors through the
staves to duplicate aging and the condenser recovers this vapor as liquid
and returns it to the vessel. The pressure equipment provides for further
controls over the aging process potentially useful in producing whiskey
of a desired quality. Finally, internal heating coils provide for temperature
control of the aging whiskey.

The large cost savings in the system occur in three areas. First, the labor and wood cost of the barrels is reduced by using straight wood staves and using less wood per volume of whiskey stored. Second, the loss of whiskey through evaporation is eliminated since the system captures the vapors and returns them after condensation. Third, the warehouse area is reduced since the system requires only 1/10th the volume. The cost savings that result can be substantial, up to 50 percent of present aging costs.

The system's most important feature of the system from an emission standpoint is the complete elimination of whiskey loss. Loss during aging is eliminated since ethanol evaporating through the staves is captured in the air spaces manifolded to the condensers, which return the vapor as liquid to the vessel. Soakage losses are reduced since the alcohol remaining in the used staves is partially recovered by continuing to draw a vacuum after the whiskey is emptied. The vacuum evaporates the ethanol in the staves and draws it to the condensers where the ethanol is recovered. Finally, any losses due to spillage and barrel leaks are eliminated since the whiskey is piped into and out of the aging vessels. Thus, the system has the capacity to be almost loss free.

The key factor determining the system's applicability to whiskey aging and emission reduction is the quality of the whiskey produced. Since testing of the system has not been completed, it is not known if the system will properly age whiskey. Testing of the system is scheduled for 1978.

4.6 CONTROL OF BARREL SOAKAGE LOSSES

The major control device discussed to this point, carbon adsorption, is applicable only to the control of evaporation during barrel storage; control of losses due to soakage in the barrel staves would require additional measures. These measures, along with present uncontrolled practices, are described below.

Present practice is to rinse used barrels with one gallon of water before selling or storing the barrels. The amount of whiskey recovered in this manner appears to be low since such a rinse removes only the surface film of whiskey on the barrel staves. One distiller practices a more complete rinse using 3 gallons of water and rolling and shaking the barrel to improve recovery. This practice removes approximately one half gallon from the barrel wood, or about .7 kg ethanol.[14] This is less than 20 percent of the estimated 3.8 kg of ethanol in the barrel wood. Thus, present practices recover only a small percent of the liquid soakage in whiskey barrels. No other systems to further recover barrel soakage are in practice.

Three types of systems have potential applicability: more complete rinsing, vacuum evaporation, and steaming. More complete rinsing could be accomplished using a greater amount of water, greater agitation of the barrel, more than one rinse and heating the water. Vacuum evaporation would involve connecting the used barrel to a vacuum source to draw out the vapors. Vacuum is available at most distillers since vacuum evaporation is used to dry spent grain for animal feed. Steaming would involve passing steam through the barrel, using the heat to evaporate the ethanol in the wood. The steam would then be condensed to recover the ethanol. The dilute whiskey produced in these methods could be used in adjusting the proof of bottled whiskey. Whiskey is typically diluted before bottling, since it is aged at higher proofs than those at which it is marketed.

Two factors appear to limit the effectiveness of all three recovery methods, the inherent slowness of diffusion in wood and the barrel configuration. The physical mechanisms, extraction, heat, and vacuum evaporation, on which the recovery methods are based all attempt to increase the rate of diffusion of ethanol through the wood. However, the small pore structure of the wood and the great width of the stave (2 cm is a considerable distance in terms of molecular diffusion) results in extremely slow diffusion; 3 to 6 months are required to saturate the wood after filling the barrels. Even if a hundred fold increase in the diffusion rate could be achieved, more than a day would be required to recover all ethanol in the barrel staves. In addition, the barrel configuration does not allow optimum contacting in rinsing and steaming. Water touches only a small percentage of the wood at any one time in rinsing, and unless extra holes or special spargers are provided, steam distribution inside a barrel would be uneven and steam contact with the walls poor.

It would appear that other methods of recovery of barrel soakage losses might be necessary. These methods would require methods of operation both unfamiliar to the whiskey industry and complex. They would involve splintering the barrels into small slivers of wood, passing the slivers through water extraction and vacuum filtration and evaporation. The slivers would then be available as fuel. Alternately, the saturated wood slivers or the saturated staves themselves could be fed to a boiler. Adjustments in the boiler operation would be required to assure proper firing with saturated wood as a partial fuel. As noted, these operations would be complex, but could be technically possible and, with credit for the wood fuel and recovered ethanol, financially feasible. However, no analysis of this option was made.

One final method may be feasible, storage of the empty barrels in enclosed warehouses vented to a carbon adsorber. An economic analysis of this option is shown

on Table 4-5. The analysis assumes that nine months of storage would be required to remove 85 percent of the liquid in the barrel wood and that the first 20 percent of the liquid would have been removed by water rinsing. Thus, assuming 3.8 kilograms of ethanol in the wood, the system would recover .65(3.8) or 2.5 kg from each barrel. A warehouse ethanol concentration of 250 ppm was chosen since a low concentration would be required to evaporate the liquid from the wood. Finally the recovery efficiency was set at 95 percent or better since no special features would be required to protect whiskey quality. The final cost of the system is 2.8¢/proof gallon whiskey.

Since many of the design parameters used in the analysis were based only on engineering judgement, the final cost figure for this control system could change significantly in actual practice. The nine month time period, the 85 percent removal and the 250 ppm ethanol level need to be verified before the system can be finally judged. However, the analysis does give a preliminary indication of the system's feasibility and shows that further study is warranted.

Table 4-5

Control System for Barrel Soakage
Losses - Warehousing

Assumptions	Storage period:	9 months
	Ethanol level:	250 ppm
	Total Barrel soakage:	3.8 kg ethanol
	Warehouse capacity:	50,000 barrels
Recovery on Adsorber	Removal from barrel	85 percent
		20 percent from rinsing
		65 percent from storage
	95 percent	
Design	Emission rate:	3.3 kg ethanol/yr-barrel slot
	Adsorber size:	21,900 scfm
	Surface Area:	292 ft^2
	Carbon:	35,040 lbs
	Recovery:	104050 pg
	Steam:	1.03 $(10)^6$ lbs/yr
Costs	Annualized Capital Cost:	$46,000
	Taxes, Insurance, etc:	$12,260
	Electricity:	$ 7,730
	Steam:	$ 1,750
	Carbon:	$ 5,000
	Maintenance:	$ 8,640
	Warehouse-Depreciation[15]	$15,000
	Handling (50¢/barrel)[15]	$33,330
		$129,710/yr
	Recovery Credit	$55,150
	Net Cost	$74,560/yr
	Cost/proof gallon	2.8¢

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14. Trip Report by Terry Briggs, PEDCo, Cincinnati, Ohio, on a visit to Jim Beam Distillery, Clermont County, Kentucky. April 7, 1977.

15. Reference 13.

APPENDIX A.   EMISSIONS FROM THE PRODUCTION
OF UNAGED WHISKEY

The production of unaged whiskey involves preparation and fermentation of grain and distillation of the resulting liquid to produce unaged whiskey. The three largest sources of volatile organic emissions in this operation are the fermentor vent, the distillation column vents and the drying of the used grain.

The fermentation of grain in whiskey manufacture produces large amounts of carbon dioxide. This carbon dioxide exits from the fermentor by vents on the top and carries with it minor amounts of ethanol. A measured value for this emission is 183 g ethanol/m^3 grain.[1] Using 146 proof gallons whiskey/m^3 grain, and a production of whiskey of 79.2 x 10^6 proof gallons in 1976, the total nationwide emissions from this source are 99 MT/yr. A typical large distillery producing 4 x 10^6 proof gallons whiskey/year would emit 5.0 MT/yr.

In the operation of the various distillation columns in a distillery, ethanol is emitted from the inert vents on the column condensers. However, with the double condenser system commonly used and condenser temperatures of 70 to 90°F, these emissions are low. One emission estimate is 0.0022 kg ethanol/proof gallon-column.[2] Using the whiskey production above, and assuming 1.5 columns/distillery as an average, the total nationwide emissions from this source are 260 MT/yr. A typical large distillery with a 3 distillation column system producing 4 x 10^6 proof gallons/year would emit 26.4 MT/yr.

The grain remaining after fermentation and distillation is typically dried and sold as animal feed. During drying some of the residual ethanol in the grain is evaporated to the air. The ethanol content of the grain slurry remaining after distillation is 0.1 to 0.01 percent by weight;[3] however, a large portion of this ethanol would be mixed with the wastewater removed from grain slurry. Assuming 0.05 percent ethanol in the grain and that 30 percent is evaporated to the air, the nationwide emissions are 206 MT/yr. A large distillery producing 4×10^6 proof gallons/yr would emit 10.1 MT/yr.

The typical large distillery described in this appendix is analagous to the typical distillery in Chapter 3.0. That distillery had emissions of 1460 MT/yr from aging; the total emissions from the emission points described in this appendix is 41.3 MT/yr, less than 3 percent of the aging emissions.

REFERENCES APPENDIX A

1. Telephone conversation between Mr. Lew Heckman, EPA Region II, New York, New York, and David C. Mascone, U.S. EPA, February 9, 1977.

2. Carter, R. V., and B. Limisky. Gaseous Emissions from Whiskey Fermentation Units. Atmospheric Environment. 8:57-62. 1974.

3. Telephone conversation between Dr. Allen Thomas, Brownforeman Distillery, Louisville, Kentucky and David C. Mascone, U.S. EPA, Research Triangle Park, N.C., December 22, 1976.

4. Trip Report by Terry Briggs, PEDCo, Cincinnati, Ohio, on a meeting with the DISCUS technical committee, March 30, 1977.

WHISKEY BY VARIOUS PERIODS OF PRODUCTION REMAINING IN BONDED WAREHOUSES IN KENTUCKY AS OF DECEMBER 31, 1975

Prepared from information obtained at the Office of the Department of Revenue of the Commonwealth of Kentucky

DISTILLERY	REMAINING WHISKEY PRODUCED OR RECEIVED — BOTTLED IN BOND — AGE — CALENDAR YEAR ENDING DECEMBER 31									TOTAL	
	Over 8 Years	1968 No. Barrels	1969 No. Barrels	1970 No. Barrels	1971 No. Barrels	1972 No. Barrels	1973 No. Barrels	1974 No. Barrels	1975 No. Barrels	No. Barrels	Per Cent
Barton Brands, Inc. Bardstown, D.S.P. Ky. 12	25,829	10,506	34,533	53,657	34,464	1,544	64,279	16,831	20,248	261,981	4.26
Jas. B. Beam Distilling Co. Bardstown, Kentucky								41,233	13,320	54,553	799,601
Beam, Ky.	5,698	2,122	303	1,110	17,572	91,239	98,247	64,014	58,948	339,253	13.01
Clermont, Ky.	12,069	25,207	14,981	31,594	24,102	84,464	78,559	74,076	60,743	405,795	
Blair Distilling Co. St. Francis, Ky.			4,523	4,336	328		531			9,718	.16
J.T.S. Brown's Son Co. Lawrenceburg, Ky.	4,450	24,761	28,391	10,582	13,816					82,000	1.33
Brown-Forman Distillers Corp. (3 Units) Louisville, Ky.	858	2,783	4,321	37,320	60,514	63,371	41,940	104,437	97,000	412,444	6.70
Commonwealth Distillers, Inc. (Formerly T.W. Samuels) Deatsville, Ky.	11,299	5,625	7,071	4,266						28,261	.46
Double Springs Distilling Co. Bardstown, Ky.	2,470	8,214	4,538	7,190	6,540	3,928	5,644			38,524	94,833
Frankfort, Ky.	1,399	1,642	5,928		10,753	16,731	15,380	1,800		53,633	1.54
Louisville, Ky.	1,243	1,019	389	25						2,676	
Fleischmann Distilling Corp. Owensboro, Ky.		208	5,412	35,963	30,412	36,411	35,413	38,568	30,901	213,288	3.47
Glenmore Distilleries Co. Owensboro, Ky.	6,621	24,968	8,988	25,111	45,418	40,017	29,884			181,007	2.94
Yellowstone, Inc. Louisville, Ky.		3,311	10,577	23,637	20,891	18,236	13,076	10,816	1,117	101,661	1.65
Heaven Hill Distilleries, Inc. Bardstown, Ky.	13,207	24,058	35,726	49,775	66,816	62,141	64,771	53,868	47,429	417,791	6.30
Hoffman Distilling Co. Lawrenceburg, Ky.	6,768	1,423	869	824	2,099					11,983	.20
Medley Distilling Co. Owensboro, Ky.	844	1,275	6,759	3,137	31,098	28,745	29,721	17,928	9,713	129,220	2.16
Ben F. Medley Distillery Stanley, Ky.	75		35		119					229	.01
National Distillers & Chem. Corp. (3 Units) Louisville, Ky.	1,493	12,258	96,993	133,920	126,436	99,304				470,404	1,031,752
(3 Units) Frankfort, Ky.	1,411	7,749	124,302	152,553	151,814	106,923			66,605	611,348	17.59
Austin Nichols Distilling Lawrenceburg, Ky.	3,413	16,083	23,202	20,050	14,685	22,763	23,552	30,226	17,446	171,420	188,152
Jessamine County, Ky.									16,732	16,732	3.06

WHISKEY BY VARIOUS PERIODS OF PRODUCTION REMAINING IN BONDED WAREHOUSES IN KENTUCKY AS OF DECEMBER 31, 1975

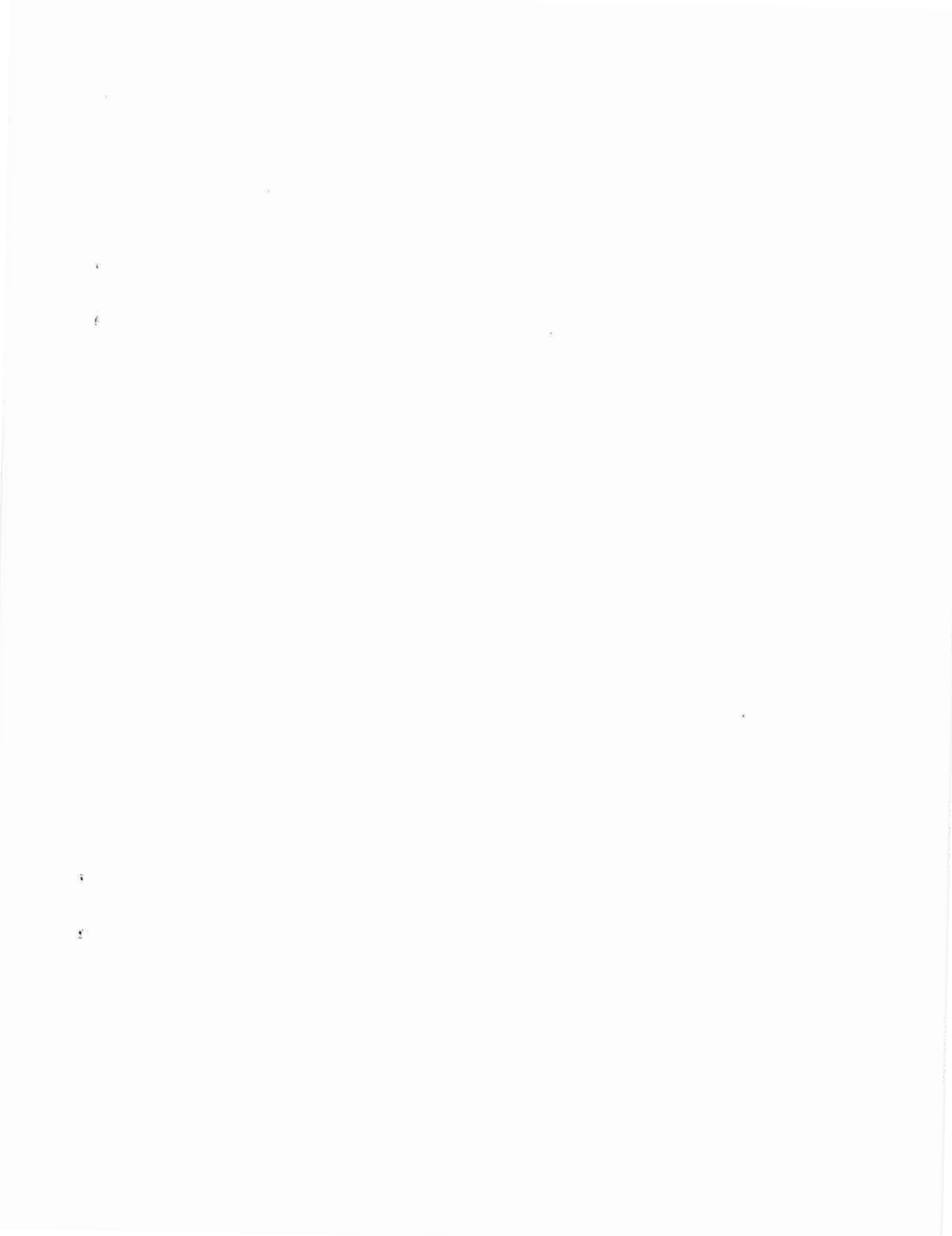Prepared from information obtained at the Office of the Department of Revenue of the Commonwealth of Kentucky.

DISTILLERY	REMAINING WHISKEY PRODUCED OR RECEIVED BOTTLED IN BOND — AGE CALENDAR YEAR ENDING DECEMBER 31									TOTAL	
	Over 8 Years	1968 No. Barrels	1969 No. Barrels	1970 No. Barrels	1971 No. Barrels	1972 No. Barrels	1973 No. Barrels	1974 No. Barrels	1975 No. Barrels	No. Barrels	Per Cent
Old Boone Distillery Co. Meadowlawn, Ky.	14,254	4,783	3,726	1,483	269	2,142	9,812	3,314	3,997	43,780	.71
Old Fitzgerald Distillery, Inc. Louisville, Ky.	6,107	36,252	61,382	51,119	50,417	38,420	10,969	9,962	9,287	273,915	4.45
Schenley Industries, Inc. Bernheim Distilling Co. Louisville, Ky.	6,209	27,569	38,212	22,478	21,692	53,988	108,108	44,987	47,436	370,679	1,102,515
Park & Tilford Dist. of Ky. Louisville, Ky.	6,062	2,679	3,922	14,727		5,543	9,767	16,185		58,885	17.93
The Geo. T. Stagg Co. Bardstown, Ky.	32,634	510	9,614	1,284	2,991	10,428	18,222	10,309	19,719	105,711	
Frankfort, Ky.	49,972	23,492	31,842	19,593	43,242	92,417	114,147	58,934	133,601	567,240	
Joseph E. Seagram & Sons, Inc. Louisville, Ky.	12,459	23,900	39,558	16,459	26,330	17,593	5,308	11,089	21,825	174,576	641,003
Cynthiana, Ky.	1,762	3,616	8,351	4,898	2,143	661	1,389			22,820	10.43
Lawrenceburg, Ky.		2,575	1,145	369	75					4,164	
Huntington Creek Corp. Coxs Creek, Ky.	12,733	48,447	139,235	84,539	53,969	40,305	25,791	34,424		439,443	
Star Hill Distilling Co. Loretto, Ky.	462	1,188	2,789	3,648	4,934	6,001	6,491	5,637	4,975	36,125	.59
Willett Distilling Co. Bardstown, Ky.	5,349	1,271	4,210	5,343	4,711	75	2,875	3,942	4,522	37,328	.61
Totals Each Year Dec. 31, 1975	247,150	349,575	761,357	820,990	868,700	943,335	313,766	657,580	685,564		
Totals All Years Dec. 31, 1975										6,148,587	
Totals December 31, 1974	235,498	608,963	995,317	960,854	1,018,144	943,578	846,142	748,722		6,683,654	
Totals December 31, 1973	230,085	886,818	1,159,606	1,100,151	1,014,776	1,024,001	1,004,877			7,285,998	
Totals December 31, 1972	177,515	1,149,734	1,335,124	1,114,402	1,070,059	1,081,542				7,514,642	
Totals December 31, 1971	214,333	1,306,734	1,354,324	1,170,710	1,171,858					7,877,969	
Totals December 31, 1970	331,462	1,428,095	1,462,894	1,391,309						8,491,893	
Totals December 31, 1969	413,702	1,496,524	1,653,901							8,609,815	
Totals December 31, 1968	504,299	1,731,446								8,706,688	

Note — Fractional barrels reduced to one full barrel. Storage does not necessarily represent ownership.

TECHNICAL REPORT DATA
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1. REPORT NO. EPA-450/2-78-013	2.	3. RECIPIENT'S ACCESSION NO.

4. TITLE AND SUBTITLE Cost and Engineering Study - Control of Volatile Organic Emissions from Whiskey Warehousing	5. REPORT DATE April 1978
	6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S) David C. Mascone, ESED	8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Environmental Protection Agency Office of Air and Waste Management Office of Air Quality Planning and Standards Research Triangle Park, North Carolina 27711	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO.

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	14. SPONSORING AGENCY CODE 200/04

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This document provides cost and engineering information on control of volatile organic emissions from whiskey warehousing. Included are a description of whiskey aging, warehousing, and of volatile organic emissions from warehousing; a development of emission factors and inventories for these emissions; a cost and engineering analysis of available control techniques for these emissions; and a discussion of volatile organic emissions from other whiskey manufacturing operations. The major control technique discussed is carbon adsorption.

17.	KEY WORDS AND DOCUMENT ANALYSIS	
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Whiskey Warehousing Whiskey Aging Ethanol Carbon Adsorption	Air Pollution Control Stationary Sources Organic Vapors	

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PHILLIP J. SHEPHERD
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GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION FOR AIR QUALITY
803 Schenkel Lane
Frankfort, Kentucky 40601-1403
June 27, 1994

Mr. H. Edward O'Daniel, Jr.
President
Kentucky Distillers Association
110 West Main Street
Springfield, Kentucky 40069

RE: Fugitive ethanol emissions
      Inquiry #10754

Dear Mr. O'Daniel:

        This is in response to your letter dated June 7, 1994, regarding the emissions of ethyl
alcohol from aging warehouses. As with emissions from whiskey barrels, the Cabinet considers
ethanol emissions from aging warehouses to be fugitive emissions as defined in Regulation 401
KAR Chapters 50 and 51.

        Should you need additional information please contact me or Mr. James W. Dills, of my
staff, for assistance.

                                Sincerely,

                                [signature: John E. Hornback]

                                John E. Hornback, Director

JEH/ALE/mlc
cc: James W. Dills

                                                                    Exhibit D

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TN. DIVISION OF
AIR POLLUTION CONTROL
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

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345 COURTLAND STREET
ATLANTA, GEORGIA 30365

Lida - please 8/24
cc Oliver JWS
T ERF

CC 6RS

AUG 19 1994

4APT-AEB

Mr. John W. Walton, P.E.
Director
Division of Air Pollution Control
Tennessee Department of Environment
    & Conservation
L & C Annex, 9th Floor
401 Church Street
Nashville, TN 37243-1531

Dear Mr. Walton:

    Your letter of June 28, 1994, to Carla Pierce of the Air,
Pesticides and Toxics Management Division requested that the
Environmental Protection Agency (EPA) provide a determination
regarding evaporative emissions from whiskey warehouses.
Specifically, your letter requested that EPA determine, from a
Title V perspective, whether windows and screen panels contained
at the warehouses qualify as "functionally equivalent openings".
The letter stated that Division personnel at present interpret
such openings as stack sources. In response to your request, our
Region contacted EPA Headquarters to ascertain their opinion.

Functionally Equivalent Openings

    Historically, EPA has considered "functionally equivalent
openings" as emission points which allow measurement of pollution
concentration or air flow rate. At present, EPA does not
consider windows and screen panels to fall within this
definition; however, this does not preclude your agency from
adopting a more stringent definition.

Title V Source Applicability
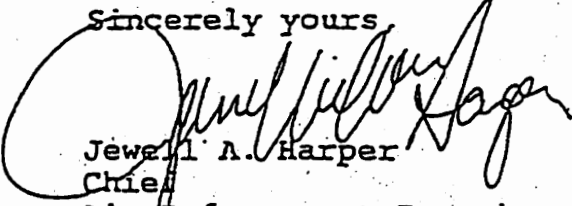
    Should your agency adhere to a stricter interpretation of
"functionally equivalent opening", such emissions should be
counted as stack emissions for Title V purposes.

    If the evaporative emissions are determined to be fugitive
emissions, then any VOC constituent which also appears on the
list of 189 hazardous air pollutants (HAP) created pursuant to
Section 112(b) of the Clean Air Act, must be counted toward major
source determination (see "major source" definition in 40 CFR
§ 70.2(1)).

Exhibit E

If you should have any questions regarding this letter, please contact Mr. Alan Drake of my staff at 404/347-5014.

Sincerely yours,

Jewell A. Harper
Chief
Air Enforcement Branch
Air, Pesticides and Toxics
Management Division

9.12.3 Distilled Spirits

9.12.3.1 General[1-2]

The distilled spirits industry includes the production of whisky, gin, vodka, rum, and brandy. The production of brandy is discussed in AP-42 Section 9.12.2, "Wines and Brandy". Distilled spirits production also may include the production of secondary products such as distillers dried grains used for livestock feed and other feed/food components.

Distilled spirits, including grain spirits and neutral spirits, are produced throughout the United States.[1] The Bureau of Alcohol, Tobacco, and Firearms (BATF) has established "standards of identity" for distilled spirits products.[2]

9.12.3.2 Process Description[3-4]

Distilled spirits can be produced by a variety of processes. Typically, in whisky production, grains are mashed and fermented to produce an alcohol/water solution, that is distilled to concentrate the alcohol. For whiskies, the distilled product is aged to provide flavor, color, and aroma. This discussion will be limited to the production of Bourbon whisky. Figure 9.12.3-1 is a simple diagram of a typical whisky production process. Emission data are available only for the fermentation and aging steps of whisky production.

9.12.3.2.1 Grain Handling And Preparation -
Distilleries utilize premium cereal grains, such as hybrid corn, rye, barley, and wheat, to produce the various types of whisky and other distilled spirits. Grain is received at a distillery from a grain-handling facility and is prepared for fermentation by milling or by malting (soaking the grains to induce germination). All U.S. distillers purchase malted grain instead of performing the malting process onsite.

9.12.3.2.2 Grain Mashing -
Mashing consists of cooking the grain to solubilize the starch from the kernels and to convert the soluble starch to grain sugars with barley malt and/or enzymes. Small quantities of malted barley are sometimes added prior to grain cooking. The mash then passes through a noncontact cooler to cool the converted mash prior to entering the fermenter.

9.12.3.2.3 Fermentation -
The converted mash enters the fermenter and is inoculated with yeast. The fermentation process, which usually lasts 3 to 5 days for whisky, uses yeast to convert the grain sugars into ethanol and carbon dioxide. Congeners are flavor compounds which are produced during fermentation as well as during the barrel aging process. The final fermented grain alcohol mixture, called "beer", is transferred to a "beer well" for holding. From the beer well, the beer passes through a preheater, where it is warmed by the alcohol vapors leaving the still, and then to the distillation unit. The beer still vapors condensed in the preheater generally are returned to the beer still as reflux.

Figure 9.12.3-1. Whisky production process.
(Source Classification Codes in parentheses).

9.12.3.2.4 Distillation -

The distillation process separates and concentrates the alcohol from the fermented grain mash. Whisky stills are usually made of copper, especially in the rectifying section, although stainless steel may be used in some stills. Following distillation, the distilled alcohol spirits are pumped to stainless steel tanks and diluted with demineralized water to the desired alcohol concentration prior to filling into oak barrels and aging. Tennessee whisky utilizes a different process from Bourbon in that the distillate is passed through sugar maple charcoal in mellowing vats prior to dilution with demineralized water.

9.12.3.2.5 Grain And Liquid Stillage ("Dryer House Operations") -

In most distilleries, after the removal of alcohol, still bottoms (called whole stillage), are pumped from the distillation column to a dryer house. Whole stillage may be sold, land applied (with permitting), sold as liquid feed, or processed and dried to produce distillers dried grains (DDG) and other secondary products. Solids in the whole stillage are separated using centrifuges or screens; the liquid portion (thin stillage) may be used as a backset or concentrated by vacuum evaporation. The concentrated liquid may be recombined with the solids or dried. Drying is typically accomplished using either steam-heated or flash dryers.

9.12.3.2.6 Warehousing/Aging -

Aging practices differ from distiller to distiller, and even for the same distiller. Variations in the aging process are integral to producing the characteristic taste of a particular brand of distilled spirit. The aging process, which typically ranges from 4 to 8 years or more, consists of storing the new whisky distillate in oak barrels to encourage chemical reactions and extractions between the whisky and the wood. The constituents of the barrel produce the whisky's characteristic color and distinctive flavor and aroma. White oak is used because it is one of the few woods that holds liquids while allowing breathing (gas exchange) through the wood. Federal law requires all Bourbon whisky to be aged in charred new white oak barrels.

The oak barrels and the barrel environment are key to producing distilled spirits of desired quality. The new whisky distillate undergoes many types of physical and chemical changes during the aging process that removes the harshness of the new distillate. As whisky ages, it extracts and reacts with constituents in the wood of the barrel, producing certain trace substances, called congeners, which give whisky its distinctive color, taste, and aroma.

Barrel environment is extremely critical in whisky aging and varies considerably by distillery, warehouse, and even location in the warehouse. Ambient atmospheric conditions, such as seasonal and diurnal variations in temperature and humidity, have a great affect on the aging process, causing changes in the equilibrium rate of extraction, rate of transfer by diffusion, and rate of reaction. As a result, distillers may expose the barrels to atmospheric conditions during certain months, promoting maturation through the selective opening of windows and doors and by other means.

Distillers often utilize various warehouse designs, including single- or multistory buildings constructed of metal, wood, brick, or masonry. Warehouses generally rely upon natural ambient temperature and humidity changes to drive the aging process. In a few warehouses, temperature is adjusted during the winter. However, whisky warehouses do not have the capability to control humidity, which varies with natural climate conditions.

9.12.3.2.7 Blending/Bottling -

Once the whisky has completed its desired aging period, it is transferred from the barrels into tanks and reduced in proof to the desired final alcohol concentration by adding demineralized water.

Following a filtration process that renders it free of any solids, the whisky is pumped to a tank in the bottling house, bottled, and readied for shipment to the distributors.

9.12.3.3 Emissions And Controls[3-6]

9.12.3.3.1 Emissions -

The principal emissions from whisky production are volatile organic compounds (VOCs), principally ethanol, and occur primarily during the aging/warehousing stage. In addition to ethanol, other volatile compounds, including acetaldehyde (a HAP), ethyl acetate, glycerol, fusel oil, and furfural, may be produced in trace amounts during aging. A comparatively small source of ethanol emissions may result from the fermentation stage. Smaller quantities of ethyl acetate, isobutyl alcohol, and isoamyl alcohol are generated as well; carbon dioxide is also produced during fermentation. Particulate matter (PM) emissions are generated by the grain receiving, handling, drying, and cleaning processes and are discussed in more detail in AP-42 Section 9.9.1, Grain Elevators and Processes. Other emissions, including SO_2, CO_2, CO, NO_x, and PM may be generated by fuel combustion from power production facilities located at most distilled spirits plant.

Ethanol and water vapor emissions result from the breathing phenomenon of the oak barrels during the aging process. This phenomenon of wood acting as a semipermeable membrane is complex and not well understood. The emissions from evaporation from the barrel during aging are not constant. During the first 6 to 18 months, the evaporation rate from a new barrel is low because the wood must become saturated (known as "soakage") before evaporation occurs. After saturation, the evaporation rate is greatest, but then decreases as evaporation lowers the liquid level in the barrel. The lower liquid level decreases the surface area of the liquid in contact with the wood and thus reduces the surface area subject to evaporation. The rate of extraction of wood constituents, transfer, and reaction depend upon ambient conditions, such as temperature and humidity, and the concentrations of the various whisky constituents. Higher temperatures increase the rate of extraction, transfer by diffusion, and reaction. Diurnal and seasonal temperature changes cause convection currents in the liquid. The rate of diffusion will depend upon the differences in concentrations of constituents in the wood, liquid, and air blanketing the barrel. The rates of reaction will increase or decrease with the concentration of constituents. The equilibrium concentrations of the various whisky components depend upon the humidity and air flow around the barrel.

Minor emissions are generated when the whisky is drained from the barrels for blending and bottling. Residual whisky remains in the used barrels both as a surface film ("heel") and within the wood ("soakage"). For economic reasons, many distillers attempt to recover as much residual whisky as possible by methods such as rinsing the barrel with water and vacuuming. Generally, barrels are refilled and reentered into the aging process for other distilled spirits at the particular distiller or sealed with a closure (bung) and shipped offsite for reuse with other distilled spirits. Emissions may also be generated during blending and bottle filling, but no data are available.

9.12.3.3.2 Controls -

With the exception of devices for controlling PM emissions, there are very few emission controls at distilleries. Grain handling and processing emissions are controlled through the use of cyclones, baghouses, and other PM control devices (see AP-42 Section 9.9.1). There are currently no current control technologies for VOC emissions from fermenters because the significant amount of grain solids that would be carried out of the fermenters by air entrainment could quickly render systems, such as carbon adsorption, inoperable. Add-on air pollution control devices for whisky aging warehouses are not used because of potential adverse impact on product quality. Distillers ensure that barrel construction is of high quality to minimize leakage, thus reducing ethanol emissions. Ethanol recovery would require the use

of a collection system to capture gaseous emissions in the warehouse and to process the gases through a recovery system prior to venting them to the atmosphere.

9.12.3.3.3 Emission Factors -
Table 9.12.3-1 provides uncontrolled emission factors for emissions of VOCs from fermentation vats and for emissions of ethanol from aging due to evaporation. Because ethanol is the principal VOC emission from aging, the ethanol emissions factors are reasonable estimates of VOC emissions for these processes. Emission factors for grain receiving, handling, and cleaning may be found in AP-42 Section 9.9.1, Grain Elevators and Processes. Emission factors are unavailable for grain mashing, distillation, blending/bottling, and spent grain drying. An emission factor for carbon dioxide from fermentation vats is also unavailable, although carbon dioxide and ethanol are theoretically generated in equal molecular quantities during the fermentation process.

Table 9.12.3-1. EMISSION FACTORS FOR DISTILLED SPIRITS[a]

EMISSION FACTOR RATING: E

Source[b]	Ethanol	Ethyl acetate	Isoamyl Alcohol	Isobutyl Alcohol
Grain mashing (SCC 3-02-010-13)	NA	NA	NA	NA
Fermentation vats (SCC 3-02-010-14)	14.2[c]	0.046[c]	0.013[c]	0.004[c]
Distillation (SCC 3-02-010-15)	ND	ND	ND	ND
Aging (SCC 3-02-010-17)				
- Evaporation loss[d]	6.9[e]	ND	ND	ND
Blending/bottling (SCC 3-02-010-18)	ND	ND	ND	ND
Dryer house operations (SCC 3-02-010-02)	ND	ND	ND	ND

[a] Factors represent uncontrolled emissions. SCC = Source Classification Code. ND = no data available. To convert from lb to kg, divide by 2.2. NA = not applicable.
[b] Emission factors for grain receiving, handling, and cleaning processes are available in AP-42 Section 9.9.1, Grain Elevators and Processes.
[c] Reference 5 (paper). In units of pounds per 1,000 bushels of grain input.
[d] Evaporation losses during whisky aging do not include losses due to soakage.
[e] References 6-7. In units of lb/bbl/yr; barrels have a capacity of approximately 53 gallons.

Recognizing that aging practices may differ from distiller to distiller, and even for different products of the same distiller, a method may be used to estimate total ethanol emissions from barrels during aging. An ethanol emission factor for aging (total loss emission factor) can be calculated based on annual emissions per barrel in proof gallons (PG). The term "proof gallon" refers to a U.S. gallon of proof spirits, or the alcoholic equivalent thereof, containing 50 percent of ethyl alcohol (ethanol) by volume. This calculation method is derived from the gauging of product and measures the difference in the amount of product when the barrel was filled and when the barrel was emptied. Fugitive evaporative

emissions, however, are not the sole difference between these two amounts. During the aging period, product soaks into the barrel, test samples are drawn, and other losses (e. g., spillage, leakage) may occur. Estimates of ethanol loss due to evaporation during aging based only on the gauging of product will produce an overestimate unless soakage and sampling losses (very small losses) are subtracted. The emission factor for evaporation loss in Table 9.12.3-1 represents an overestimate because only data for soakage losses could be calculated; data for other losses were not available.

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3.   Bujake, J. E., "Beverage Spirits, Distilled", *Kirk-Othmer Encyclopedia Of Chemical Technology*, 4th. Ed., Volume No. 4, John Wiley & Sons, Inc., 1992.

4.   *Cost And Engineering Study Control Of Volatile Organic Emissions From Whiskey Warehousing*, EPA-450/2-78-013, Emissions Standards Division, Chemical and Petroleum Branch, Office Of Air Quality Planning And Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, April 1978.

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Emission Factor Documentation for AP-42 Section 9.12.3

Distilled Spirits

Final Report

For U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emission Factor and Inventory Group

EPA Contract 68-D2-0159
Work Assignment No. 4-04

MRI Project No. 4604-04

March 1997

Emission Factor Documentation for AP-42
Section 9.12.3

Distilled Spirits

Final Report

For U. S. Environmental Protection Agency
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Emission Factor and Inventory Group
Research Triangle Park, NC 27711

Attn: Mr. Dallas Safriet (MD-14)

EPA Contract 68-D2-0159
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March 1997

NOTICE

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1. INTRODUCTION

The document *Compilation of Air Pollutant Emission Factors* (AP-42) has been published by the U. S. Environmental Protection Agency (EPA) since 1972. Supplements to AP-42 have been routinely published to add new emission source categories and to update existing emission factors. AP-42 is routinely updated by EPA to respond to new emission factor needs of EPA, State and local air pollution control programs, and industry.

An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. Emission factors usually are expressed as the weight of pollutant divided by the unit weight, volume, distance, or duration of the activity that emits the pollutant. The emission factors presented in AP-42 may be appropriate to use in a number of situations, such as making source-specific emission estimates for areawide inventories for dispersion modeling, developing control strategies, screening sources for compliance purposes, establishing operating permit fees, and making permit applicability determinations. The purpose of this report is to provide background information from test reports and other information to support revisions to AP-42 Section 9.12.3, Distilled and Blended Liquors (formerly incorporated into Section 6.5, Fermentation).

This background report consists of five sections. Section 1 includes the introduction to the report. Section 2 gives a description of the distilled spirits industry. It includes a characterization of the industry, a description of the different process operations, a characterization of emission sources and pollutants emitted, and a description of the technology used to control emissions resulting from these sources. Section 3 is a review of emission data collection (and emission measurement) procedures. It describes the literature search, the screening of emission data reports, and the quality rating system for both emission data and emission factors. Section 4 details how the revised AP-42 section was developed. It includes the review of specific data sets and a description of how candidate emission factors were developed and a summary of changes to the AP-42 section. Section 5 presents the AP-42 Section 9.12.3, Distilled Spirits. Supporting documentation for the emission factor development is presented in the Appendices.

2. INDUSTRY DESCRIPTION

The section gives a brief review of trends in the distilled spirits industry and describes the process of whisky production. Emission information is only available for fermentation and aging. Sources of volatile organic compounds (VOC), principally ethanol, are discussed, and a brief description of emission control technology is given.

2.1 INDUSTRY CHARACTERIZATION[1-4]

The fermentation industry includes the production of malt beverages (beer); wines; brandy and brandy spirits; distilled spirits; and the secondary products of all of these industries. The most commonly produced distilled spirits for beverage purposes include whiskies, gins, vodkas, rums, and brandies.[a] Whiskies are produced from fermented grain mashes and aged. Vodkas are produced from fermented grain mashes, but are not aged. Gins generally are produced from the fermented product, grain neutral spirits (GNS), to which either botanical extracts and/or flavors are added to the GNS and bottled, or dried botanicals (e.g., juniper berries) are added to the GNS to extract their oils and then distilled. Rums are made from fermented sugar cane products, such as molasses. Gins and rums may be aged in barrels. Brandies are distilled from wine or other fermented fruit juices, and are generally aged in barrels. Distilled spirits production (e.g., whisky, vodka, or gin) may produce secondary products, such as distillers dried grains used as livestock feed.

Distilled spirits are produced throughout the United States (see Table 2-1). The data presented in Table 2-1 represent production of distilled spirits as reported to the Bureau of Alcohol, Tobacco, and Firearms (BATF), U. S. Department of the Treasury. The classification of distilled spirits (SIC 2085) includes the production of distilled spirits for both beverage purposes and medicinal purposes; quantities for both of these purposes are included in the "alcohol and spirits" column of Table 2-1. Establishments engaged in manufacturing alcohol for industrial purposes are classified under SIC 2869; quantities of ethanol produced from grain for industrial purposes may also be included in Table 2-1. In Table 2-1, the production quantities for vodka are no longer reported separately by the BATF but are included in the larger category of "alcohol and spirits."

The remainder of this document is concerned primarily with the emissions resulting from the production of distilled spirits for beverage purposes. Over the last several years, the distilled spirits industry has experienced large decreases in sales. United States distilled spirits sales peaked in 1981 at approximately 189 million 9-liter cases and decreased to approximately 137 million 9-liter cases in 1994, a decline of almost 28 percent.

2.2 PROCESS DESCRIPTION[4-5]

Distilled spirits can be produced by a variety of processes. Typically, whisky production utilizes malted grains which are mashed and fermented to produce an alcohol/water solution that is distilled to concentrate the alcohol. This is not necessarily true for production of other distilled spirits, such as vodka, rum and brandy. The concentrated alcohol is usually aged in wooden barrels to provide natural color and impart flavor and aroma. Recognizing that not all distillers employ identical techniques and materials, this

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[a]Brandies are discussed in AP-42, Section 9.12.2, Wines and Brandy.

TABLE 2-1. PRODUCTION OF DISTILLED SPIRITS--1995[a,b]

State	Whisky[c] 160° and under	Whisky[c] Over 160°	Brandy	Rum	Gin	Alcohol & spirits 190° and above	Alcohol & spirits Under 190°
CA	789	0	9,089,118	0	0	15,682,949	785,878
FL	0	0	1,860,633	918,372	0	4,366,642	(88,444)
IL	0	0	0	0	2,399,822	817,619,465	3,928,243
IN	833,937	3,496,625	0	0	8,237,141	10,007,598	774,646
IA	0	0	0	0	1,341,305	429,460,453	4,336,322
KY	45,755,633	396,505	0	0	0	10,367	293,990
MI	0	0	0	0	0	0	470,141
MN	0	0	0	0	0	2,945,614	0
OH	0	0	0	0	0	866,647	0
TN	16,894,626	0	0	0	0	77,943,406	0
TX	0	0	0	0	0	36,069,118	139,225
VA	78,593	0	0	0	0	935,098	0
Other[d]	39,780	0	6,061	0	1,786,200	78,398,481	1,486,938
TOTAL	63,603,358	3,893,130	10,955,812	918,372	13,764,468	1,474,305,838	12,126,939

Source: Reference 3.

[a] Represents gross production (original plus redistillation) minus the products used in redistillation. Vodka production quantities are no longer reported separately; they are incorporated into a larger category of "alcohol and spirits."

[b] All quantities in proof gallons. Proof gallon is a U.S. gallon of proof spirits or the alcoholic equivalent thereof, i.e., a U.S. gallon containing 50 percent of ethyl alcohol (ethanol) by volume (Reference 4).

[c] Gross production of whisky includes bourbon, light, corn, and other whisky in new barrels.

[d] Includes Connecticut, Georgia, Kansas, Maryland, Massachusetts, Missouri, New Hampshire, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Puerto Rico, Washington, and Wisconsin.

section attempts to provide a generic description of distilled spirits (distillery) operations. The focus of this discussion will be on Bourbon whisky production. Processes for other distilled spirits will differ from Bourbon whisky production.

Under the standards of identity set forth by the BATF, whisky refers to an alcoholic distillate from a fermented mash of grain produced at less than 190° proof ethanol (95 percent by volume) in such a manner that the distillate possesses the taste, aroma, and characteristics generally attributed to whisky, stored in oak containers (except that corn whisky need not be so stored), and bottled at no less than 80° proof, and also includes mixtures of such distillates for which no specific standards of identity are prescribed.[b] (See Reference 6). Types of whisky and classes and types of other distilled spirits also are defined in BATF standards of identity.[6] Figure 2-1 provides a simple diagram of a typical whisky production process.

In the distilled spirits industry, there are two terms commonly used to describe the volume of the spirits: "proof gallons" and "wine gallons." The term "proof gallon" refers to a U. S. gallon of proof spirits, or the alcoholic equivalent thereof, containing 50 percent of ethyl alcohol by volume. Since excise taxes are paid on the basis of proof gallons, this term is synonymous with tax gallons. The term "wine gallon" refers to a measure of the actual volume regardless of the proof of the spirits.[4]
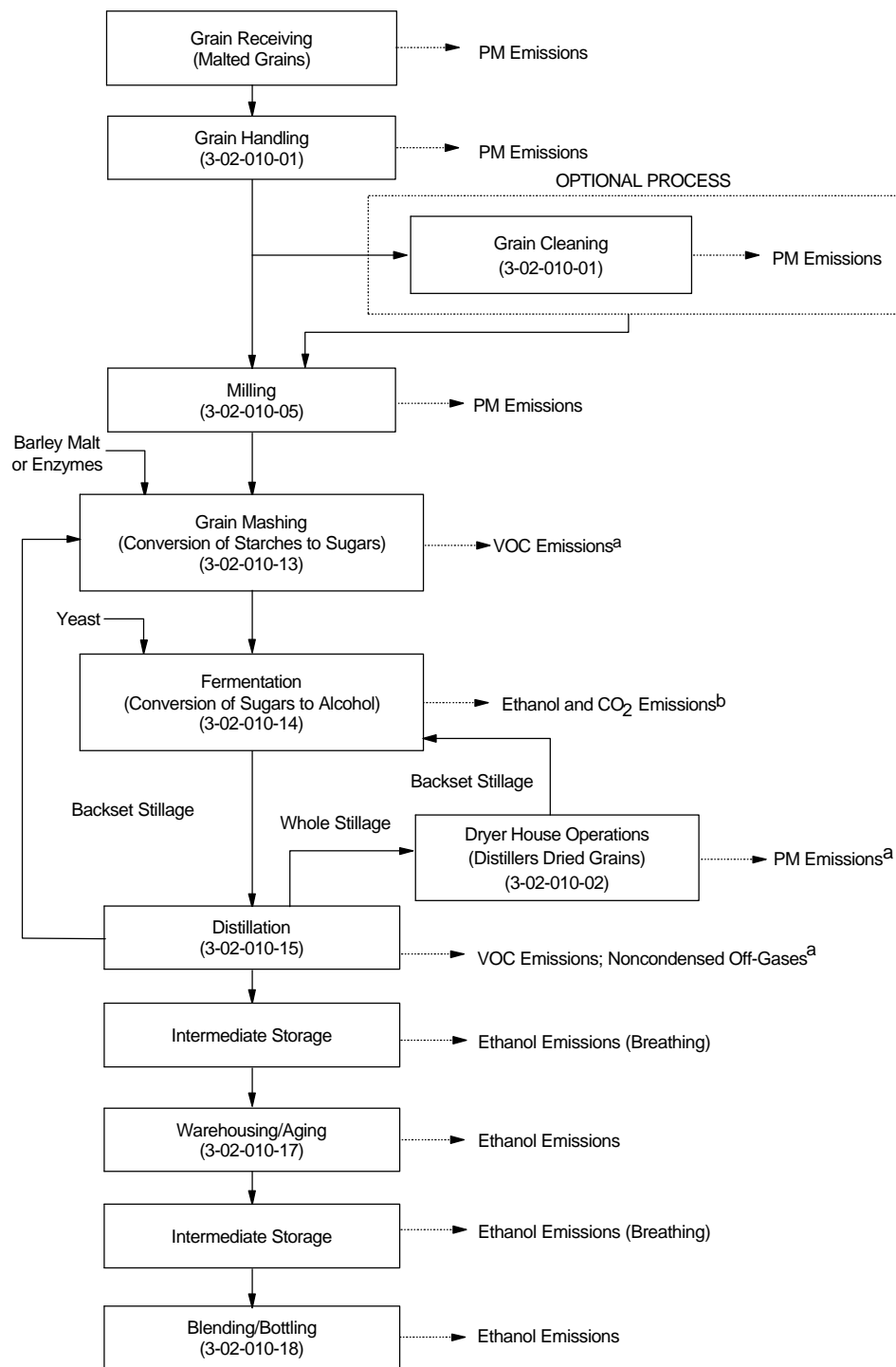
2.2.1 <u>Grain Handling and Preparation (Milling)</u>

Distilleries utilize premium cereal grains, such as hybrid corn, rye, malted barley, and wheat, to produce the various types of whisky and other distilled spirits. United States distilleries purchase malted grain instead of performing the malting process onsite. The grains have particular specifications, especially with regard to the elimination of grain with objectionable odors which may have developed in the field or during storage, handling, or drying at the elevators.

Grain receiving, handling, and cleaning are potential sources of particulate matter (PM) emissions. Grain is generally received in either hopper railcars or trucks. Grain handling is the transfer from the unloading pit by pneumatic conveyor system, auger system, and bucket elevators to and from the grain storage silos. Although it usually has been subjected to a cleaning process at the elevator, the grain may be subjected to additional cleaning, which may include a series of vibrating screens that sift out foreign materials and magnetic separators used to remove any ferromagnetic items. Dust collectors and air jets may be used to remove light materials and aid in the control of PM emissions.

Milling, which breaks the outer cellulose protective wall around the kernel and exposes the starch to the cooking and conversion process, can be accomplished by several milling methods. For example, hammer mills use a series of hammers rotating at 1,800 to 3,600 rpm within a close-fitting casing. These hammers shear the grain to a meal that is removed through a screen with different mesh sizes for various types of grain. Cage mills use a series of counter rotating bars at high speed to grind the grain by impact. Roller mills use a series of close tolerance serrated rollers to crush the grain. Distillers require an even grind, generally with a particle size as small as can be physically handled by the facility.

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[b]In the United States, 100° proof equals 50% ethanol content by volume at 15.6°C (60°F). In Canada and the United Kingdom, 87.7° proof equals 50% ethanol by volume at 10.6°C (51°F).

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Grain Receiving          ┈┈▶ PM Emissions
(Malted Grains)
        │
        ▼
Grain Handling           ┈┈▶ PM Emissions
(3-02-010-01)
        │                        OPTIONAL PROCESS
        │         ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
        │           Grain Cleaning     ┈┈▶ PM Emissions
        │         │ (3-02-010-01)                │
        │          ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
        ▼
Milling                  ┈┈▶ PM Emissions
(3-02-010-05)
Barley Malt │
or Enzymes  ▼
Grain Mashing            ┈┈▶ VOC Emissions^a
(Conversion of Starches to Sugars)
(3-02-010-13)
Yeast   │
        ▼
Fermentation             ┈┈▶ Ethanol and CO2 Emissions^b
(Conversion of Sugars to Alcohol)
(3-02-010-14)

Backset Stillage          Backset Stillage

          Whole Stillage
                    Dryer House Operations   ┈┈▶ PM Emissions^a
                    (Distillers Dried Grains)
                    (3-02-010-02)
Distillation             ┈┈▶ VOC Emissions; Noncondensed Off-Gases^a
(3-02-010-15)
        ▼
Intermediate Storage     ┈┈▶ Ethanol Emissions (Breathing)
        ▼
Warehousing/Aging        ┈┈▶ Ethanol Emissions
(3-02-010-17)
        ▼
Intermediate Storage     ┈┈▶ Ethanol Emissions (Breathing)
        ▼
Blending/Bottling        ┈┈▶ Ethanol Emissions
(3-02-010-18)
```

[a] Processes require heat. Emissions generated (e.g., CO, CO_2, NO_x, SO_2, PM, and VOCs) will depend on the source of fuel.
[b] Other compounds can be generated in trace quantities during fermentation including ethyl acetate, fuel oil, furfural, acetaldehyde, sulfur dioxide, and hydrogen sulfide. Acetaldehyde is a hazardous air pollutant (HAP).

Figure 2-1. Whisky production process.

2.2.2 Mashing

The mashing process consists of cooking (gelatinization) of the grain in water to solubilize the starches from the kernels and converting (saccharification) of the starch to "grain sugar" (primarily glucose and maltose). In general, cooking can be carried out at or above atmospheric pressure in either a batch or continuous process. During mashing, trace VOC emissions may result from constituents in the grain. Small quantities of malted barley are sometimes added prior to grain cooking. After partial cooling, conversion of the starch to sugar is accomplished by adding barley malt and/or enzymes (from other sources) to the cooked grain at approximately 63°C (145°F). The mash then passes through a noncontact cooler to a fermenter. Between the mashing and fermentation, the process generally is closed during cooling, with no emissions. Distillers may vary mashing procedures, but generally conform to basic principles, especially in the maintenance of sanitary conditions.

2.2.3 Fermentation

Fermentation, which usually lasts 3 to 5 days for whisky, involves the use of a yeast to convert the grain sugars into ethanol and carbon dioxide (CO_2). The converted grain mash is cooled prior to entering the fermenter or tank and inoculated with yeast. It is common practice to dilute the hot grain mash to its final solids concentration by adding backset stillage and/or water. Backset is liquid stillage which is screened or centrifuged from the distillation "beer still bottoms." The use of backset provides water conservation, nutrient supplements, pH adjustment of the fermentation, and some flavor components (e.g., sour mash).

The fermentation process varies slightly for the production of other distilled spirits. For instance, rum fermentations takes 1 to 2 days. In rum production, black strap molasses is the source of fermentable sugars and is stored in tanks prior to fermentation. The black strap molasses also is not "mashed" (i.e., cooked) prior to being diluted with water to obtain the proper concentration of fermentable sugars.

Congeners are flavor compounds which are produced during fermentation, as well as during the aging process. These congeners include trace aldehydes, esters, and higher alcohols (i.e., fusel oils). Lactic acid bacteria (*lactobacillus*) may simultaneously ferment within the mash and contribute to the overall whisky flavor profile. On rare occasions *lactobacillus* may provide some pH control. On other occasions, the addition of sulfuric acid, though rarely used, may result in trace hydrogen sulfide emissions from the fermentation tank.

In whisky production, significant increases in the amount of yeast consumed occur during the first 30 hours of fermentation, when over 75 percent of the carbohydrate (sugar) is converted to ethanol and carbon dioxide. Many fermentation vessels are equipped with agitation and/or cooling means that facilitate temperature control. Fermentation vessels may be constructed of wood or metal and may be open or closed top.

The final fermented grain alcohol mixture, called "beer," is agitated to resuspend its solids and may be transferred to the "beer well" storage vessel for holding until it is pumped to the "beer still." Distillers use mechanical or air agitation during transfer and storage to prevent settling of solids. In the instance of air agitation, trace amounts of aldehydes may be produced. The beer passes from the beer well through a preheater where it is warmed by the alcohol vapors leaving the still and then enters the still for distillation. The beer still vapors condensed in the preheater generally are returned to the beer still as reflux.

2.2.4 <u>Distillation</u>

The distillation process separates and concentrates the alcohol products from the fermented grain mash. In addition to the alcohol and congeners, the fermented mash contains solid grain particles, yeast cells, water-soluble proteins, mineral salts, lactic acid, fatty acids, and traces of glycerol and other trace congeners. Although many distillation processes exist, the most common systems used in the United States are the continuous beer still, with or without a doubler unit. Other distillation processes include the continuous multicolumn extractive and rectifying systems, and the batch rectifying pot still and condensing unit. Whisky stills are usually made of copper, especially in the rectifying section, although stainless steel may be used in some stills.

In a general whisky distillation process using a beer still, the whisky separating column consists of a cylindrical shell having three sections: stripping, entrainment removal, and rectifying. The stripping section contains approximately 14 to 21 perforated plates, spaced 56 to 61 cm (22 to 24 inches) apart. The fermented mash is introduced at the top of the stripping section and descends from plate to plate until it reaches the base where the stillage is discharged. Steam is introduced at the base of the column, and the vapors from the bottom of the still pass up through the perforations in the plates. Whisky stills are usually fitted with entrainment removal sections that consist of a plate above the stripping plate to remove fermented grain particles entrained in the vapor. Distillation columns operate under reflux (sealed) conditions and most vapors are condensed and collected, although small amounts of noncondensable gases will be emitted to the atmosphere. The rectifying section contains several bubble cap or valve rectifying plates in the top section of the still that produce distillates (ethanol) up to 190° proof.

The diameter of the still, the number of stripping and rectifying plates, capacity of any doubler, and proof of distillation are factors that can contribute characteristics to a particular whisky. The doubler is a type of pot still that is used to redistill the distillate from the beer still to enhance and refine the flavors desired in a specific whisky. Following distillation, the whisky, at high proof, is pumped to stainless steel tanks and diluted with demineralized water to the desired alcohol concentration prior to filling into oak barrels.

The distillation of other spirits, such as rum, is similar. Tennessee Whisky utilizes a different process than Bourbon, in that the distillate is passed through sugar maple charcoal in mellowing vats prior to dilution with demineralized water.

2.2.5 <u>Grain and Liquid Stillage ("Dryer House Operations")</u>

At most distilleries, after the removal of alcohol, still bottoms (known as whole stillage) are pumped from the distillation column to a dryer house. Whole stillage may be sold, land applied (with appropriate permitting), sold as liquid feed, or processed and dried to produce distillers dried grains (DDG). The DDG consists of proteins, fats, minerals, vitamins, and fibers which are concentrated three-fold by the removal of the grain starch in the mashing and fermentation process. Distillers' secondary products are divided into four groups: DDG, distillers dried solubles (DDS), DDG with solubles (DDG/S), and condensed distillers solubles (CDS).

Solids in the whole stillage are separated using centrifuges or screens. The liquid portion "thin stillage" may be used as a backset or may be concentrated by vacuum evaporation. The resultant syrup may be recombined with the solid portion or dried separately. This remaining mixture is then dried using one of a variety of types of dryers (usually steam-heated or flash dryers). The majority of DDG are used in

animal feed, although increasing quantities are being sold as food ingredients for human consumption due to its nutrient and fiber content.

2.2.6 Warehousing/Aging

In the aging process, both the charred oak barrel in which beverage alcohol is stored and the barrel environment are key to producing distilled spirits of desired quality and uniqueness. The aging process gives whisky its characteristic color and distinctive flavor and aroma. Variations in the aging process are integral to producing the characteristic taste of a particular brand of distilled spirits. Aging practices may differ from distillate to distiller, and even for different products of the same distiller.

Ambient atmospheric conditions, such as temperature and humidity, as well as seasonal variation, are important factors in the aging process. Aging practices vary considerably--some distillers, for example, keep their warehouse windows open during certain months to promote interaction of the aging whisky with outdoor atmospheric conditions. An EPA report observed that the aging process, in particular, depends upon the interaction of whisky in oak barrels with ambient air and particularly the temperature, humidity, and ventilation promoted by the different types of warehouse construction utilized in the industry.[5] While each distiller alters the barrel environment to produce a product with the distinctive characteristics of its brand, the fundamentals of the natural aging process are inviolate. The various distillers control the barrel environment differently by operating their warehouses in different manners; all of these variations illustrate the number of differing aging philosophies and traditions.[5]

Ethanol emissions are a natural and integral consequence of creating the distinctive qualities of various whisky production and aging embodied in the federal law. In producing Bourbon whisky, for example, ethanol from the raw beverage alcohol is unavoidably released because the wooden barrels, in which it is aged, are porous to ethanol vapors. Bourbon is typically aged for 4 years. (Not all distilled spirits are aged the same; for example, rum may be aged from 3 months to more than 1 year.)

In keeping with federal regulations and because of constituents of the barrel imparted to Bourbon in the aging process, only new charred oak barrels can be used in Bourbon production. Charred white oak barrels encourage reactions within the whisky and between the whisky and the wood to produce the desired whisky flavor. White oak is used because it is one of the few woods that holds liquids while allowing breathing (gas exchange) through the wood. These barrels used to age Bourbon are typically reused for aging other whiskies and other distilled spirits products, such as cognac, Scotch whiskey, and brandies. Most whisky barrels are reused for approximately 20 to 30 years for aging other whiskies and distilled spirits that utilize barrel aging.

When whisky ages, the alcohol extracts and reacts with constituents in the barrel wood, producing its distinctive color, taste and aroma. Constituents in the wood are transferred to the bulk liquid in the barrel by simple diffusion, by convection currents in the bulk liquid, and by temperature cycling. As the barrel heats up, the gas above the liquid increases in pressure and forces liquid into the barrel wood. When the barrel cools and the gas pressure drops, the liquid flows out of the wood into the bulk liquid, carrying wood constituents with it. The distinctive qualities of whisky are added during aging as trace substances called congeners which occur through (1) extraction of organic substances from the wood and their transfer to the whisky, (2) oxidation of the original substances and of the extracted wood material, and (3) reaction between various organic substances present in the liquid to form new products. The amber color develops and the taste of the whisky mellows during aging as the concentration of congeners increases. Similar

reactions between the barrel liquid and barrel constituents characterize aging of other distilled spirits, such as brandy and rum.

In aging or maturation, the rate of extraction of wood constituents, transfer, and reaction depend on both ambient conditions such as temperature and humidity and the concentrations of various whisky constituents. For instance, higher temperatures increase the rate of extraction, transfer by diffusion, and reaction. Diurnal and seasonal temperature changes also cause convection currents in the liquid and pressure changes in the gas affecting transfer. The rate of diffusion will depend upon the difference in concentrations of constituents in the wood, liquid, and air blanketing the barrel. The rates of reaction will increase or decrease with the concentration of constituents. Thus, changes in the airflow around the barrel would change the alcohol concentration around the barrel and impact the diffusion rate. All of these variables are integral to a particular product brand which will have its own unique taste, color, and aroma. According to the 1978 EPA report, when ventilation was artificially increased, the quality of the product was greatly impaired.

In the aging process, both the oak barrel in which the beverage is stored and the barrel environment are key to producing distilled spirits of desired quality and uniqueness. The oak barrels used for aging distilled spirits play a significant role in determining the final flavor and aroma of the beverage. Newly distilled whisky is colorless with a strong, harsh and unpalatable odor. The new whisky distillate undergoes many types of physical and chemical changes in the aging process that impart the distinctive color, taste and aroma of the whisky and gives it character. These changes include extraction of the wood compounds, decomposition and diffusion of the wood macromolecules into the alcohol, reactions of the wood and distillate compounds with each other, and oxidation produced by diffusion to ambient atmosphere. As whisky ages, the alcohol grain distillate (containing grain flavors) extracts wood flavors and color from the barrel. These congeners (oxidation products) are produced by chemical reaction induced by simple diffusion, by convection currents in the bulk liquid, and by diurnal and seasonal temperature cycling. As the barrel heats up, the gas in the headspace above the liquid increases in pressure and forces the liquid into the wood. When the barrel cools and the gas pressure drops, the liquid flows out of the wood into the bulk liquid, carrying wood constituents with it. These constituents give whisky its distinctive color, taste, and aroma. The amber color develops and the taste of the whisky mellows as it undergoes the aging cycle. Ethanol and water vapor result from the breathing phenomenon of the white oak barrels and are emitted during the aging process. As the staves become saturated with whisky, ethanol is emitted to the atmosphere as an ethanol/water vapor mixture. This phenomenon of the wood acting as a semipermeable membrane is complex and not well understood. Figure 2-2 shows a simplified illustration of the mechanisms of the whisky aging process.

The barrel environment is extremely critical in whisky aging and varies considerably by distillery and warehouse and even by location of the barrel within a warehouse. Ambient atmospheric conditions, such as seasonal variation in temperature and humidity, have a great effect on the aging process. For instance, higher temperatures in the aging warehouse increase the equilibrium rate of extraction, rate of transfer by diffusion, and rate of reaction. Furthermore, diurnal and seasonal temperature changes affect transfer rates by creating convection currents in the liquid and pressure changes in the gas. For these reasons, distillers may selectively open warehouse windows during certain months to promote interaction of the barrels with outdoor atmospheric conditions. Furthermore, the equilibrium concentrations of the various whisky components depend heavily on the air flow around the barrel. All of these variables are utilized by each distiller to produce its distinctive brand with its own unique taste, color, and aroma.

Distillers utilize various warehouse designs, which include single- or multistory buildings constructed of metal, wood, brick, or masonry. Most warehouses have no climate control systems and rely on natural ambient temperature and humidity changes to drive the aging process; in a few warehouses, temperature is adjusted in the wintertime. However, no whisky warehouses have the capability of controlling humidity, which varies with natural climatic conditions.
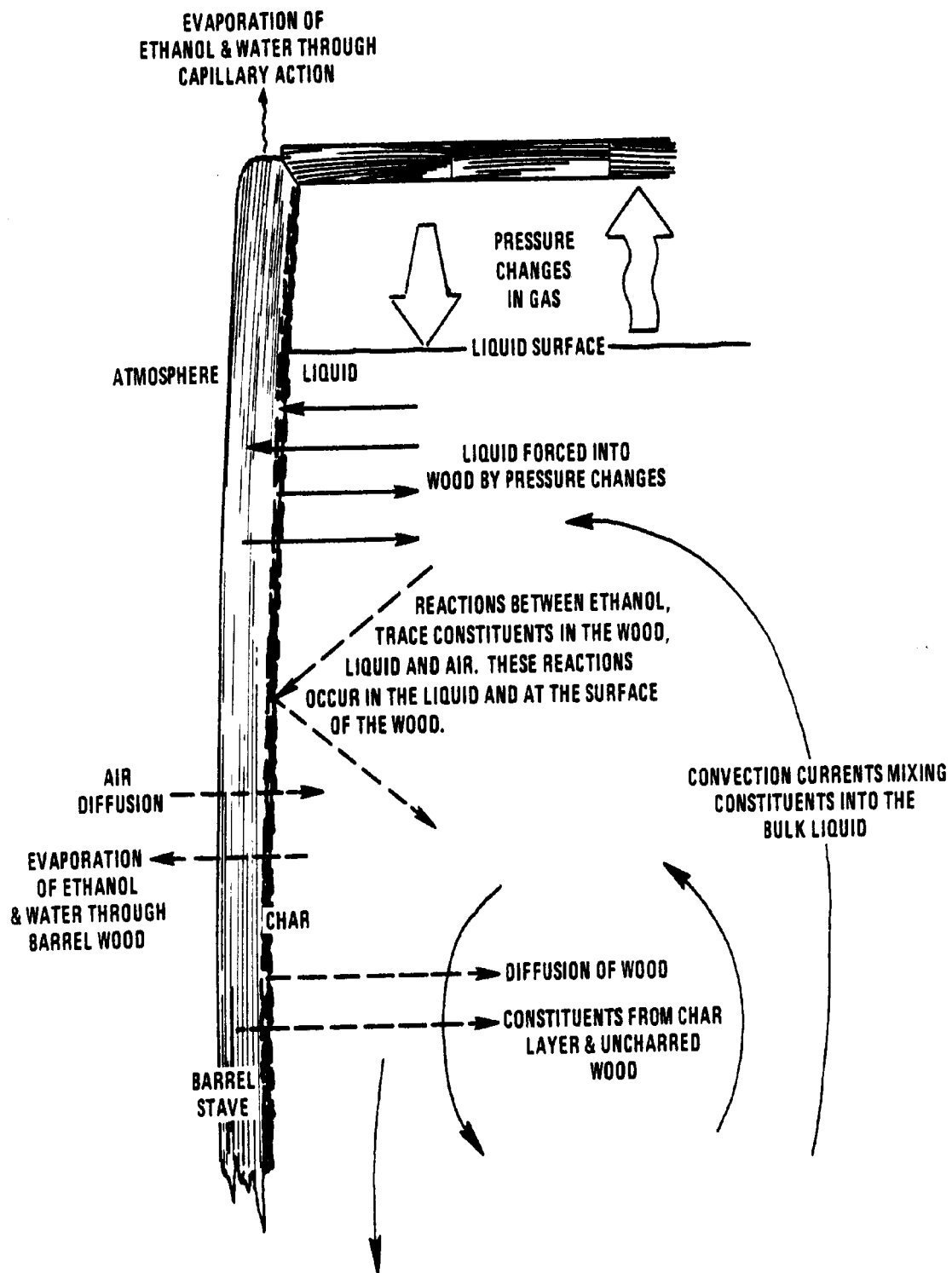
Figure 2-2. Mechanisms of whisky aging.[5]

2.2.7 Blending/Bottling

After the whisky has completed its desired aging period, it is dumped or pumped from barrels into stainless steel tanks and reduced in proof to the desired alcohol concentration by adding demineralized water. The diluted whisky is processed and filtered. Following a filtration process the whisky is pumped to a tank, proof adjusted, and bottled.

Due to their value and salability, used barrels are not generally stored but either refilled with other whiskies or bung sealed and sold to manufacturers of Scotch Whiskey, Canadian Whiskey, rum, brandy, Tequila, or wines.

New bottles are unloaded from cases and put on a conveyor belt, where they are air cleaned, filled, capped, and labeled. At the end of the conveyor belt, the final product is put into cases, which are sealed, labeled, and shipped to distributors.

2.3 EMISSIONS[4-5]

The principal emission from the production of distilled spirits is ethanol, and occurs primarily during aging/warehousing. In addition to ethanol, other volatile compounds produced in trace quantities during aging may include acetaldehyde (a HAP), ethyl acetate, glycerol, fusel oil, and furfural. A comparatively small source of ethanol emissions also results from fermentation. Carbon dioxide is also produced during fermentation; in addition, trace quantities of ethyl acetate, isobutyl alcohol, and isoamyl alcohol are also produced. Particulate matter emissions may result from the grain receiving, grain handling, grain cleaning, milling and grain drying processes; data for those emissions are contained in Section 9.9.1, Grain Elevators and Processes. Whisky production emissions are indicated by process in Figure 2-1. Other emissions, including SO_2, CO_2, CO, NO_x, VOC, and PM, may be generated by fuel combustion from power production in a typical distilled spirits plant.

The emissions from evaporation from the barrel during aging are not constant. During the first 6 to 18 months, the evaporation rate from a new barrel is low because the dry wood must become saturated (known as "soakage") before evaporation from the barrel begins. After saturation, the evaporation rate is greater, but then decreases as evaporation lowers the liquid level in the barrel. The lower liquid level decreases the surface area of the liquid in contact with the wood and thus reduces the surface area subject to evaporation. Loss rates are also affected by temperature and relative humidity. Higher temperatures expand whisky volume, force more whisky into the wood, and increase emission rates. Higher relative humidity reduces water vaporization from the barrel, reducing the emission rate. In addition, humidity affects the barrels themselves; barrels with an initial high wood moisture content shrink as relative humidity decreases, causing increased vaporization from the barrel. This shrinkage also can result in leaks, which are another potential source of emissions.

Minor VOC emissions may be generated when the whisky is drained or pumped from the barrels for blending and bottling, but no emission data are available. In addition, some residual whisky remains in used barrels as both a surface film ("heel") and within the wood ("soakage"). Much of the alcohol in this residue would eventually evaporate if the barrel is left exposed to the atmosphere for a sufficient time. For economic reasons, many distillers collect as much residual whisky as possible by using various processes, such as rinsing with water and vacuum methods.

2.4 EMISSION CONTROL TECHNOLOGY[5]

With the exception of devices for controlling PM emissions, there are few emission controls at distilleries. Grain handling and processing emissions are controlled through the use of cyclones, baghouses, and other PM controls (see AP-42 Section 9.9.1). There are no control technologies for VOC emissions from fermenters because the significant amount of grain solids that would be carried out of the fermenters by vapor entrainment could render systems, such as carbon adsorption, inoperable. Add-on air pollution control devices for whisky aging warehouses are not used because of the anticipated adverse impact that such systems would have on product quality. For economic reasons, distillers ensure that barrel construction is of high quality to minimize leakage, and processes are operated to give the highest finished product alcohol yield. If feasible without impairment of product quality, ethanol recovery would require the use of a collection system to capture gaseous emissions in the warehouse and to process the gases through a recovery system prior to venting them to the atmosphere or recirculating them through the warehouse.

REFERENCES FOR SECTION 2

1. Shea, K., "Food, Beverages and Tobacco: Basic Analysis," *Standard & Poor's Industry Surveys*, Section 3, Standard & Poor's Corporation, August 18, 1994.

2. Farren, J. M.,, et al., *U.S. Industrial Outlook '92*, U.S. Department of Commerce, Washington, D.C., 1992.

3. Bureau of Alcohol, Tobacco, and Firearms (BATF), "Monthly Statistical Release--Distilled Spirits", Department of the Treasury, Washington, DC, January 1995 through December 1995.

4. Bujake, J. E., "Beverage Spirits, Distilled," *Kirk-Othmer Encyclopedia of Chemical Technology*, 4th. Ed., Volume No. 4, John Wiley & Sons, Inc., 1992.

5. *Cost and Engineering Study Control of Volatile Organic Emissions from Whiskey Warehousing*, EPA-450/2-78-013, Emissions Standards Division, Chemical and Petroleum Branch, Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, April 1978.

6. "Standards of Identity for Distilled Spirits", 27 CFR Part 1, Subpart C, Office of the Federal Register, National Archives and Records Administration, Washington, D.C., April 1, 1996.

3. GENERAL DATA REVIEW AND ANALYSIS PROCEDURES

3.1 LITERATURE SEARCH AND SCREENING

Data for this investigation were obtained from a number of sources within the Office of Air Quality Planning and Standards (OAQPS) and from outside organizations. The AP-42 background files located in the Emission Factor and Inventory Group (EFIG) were reviewed for information on the industry, processes, and emissions. The Factor Information and Retrieval (FIRE), Crosswalk/Air Toxic Emission Factor Data Base Management System (XATEF), and VOC/PM Speciation Data Base Management System (SPECIATE) data bases were searched by SCC code for identification of the potential pollutants emitted and emission factors for those pollutants. A general search of the Air CHIEF CD-ROM also was conducted to supplement the information from these data bases.

Information on the industry, including number of plants, plant location, and annual production capacities, was obtained from the *Census of Manufactures* and other sources. A search of the Test Method Storage and Retrieval (TSAR) data base was conducted to identify test reports for sources within the distilled spirits industry. The EPA library was searched for additional test reports. Publications lists from the Office of Research and Development (ORD) and Control Technology Center (CTC) were also searched for reports on emissions from the distilled spirits industry. In addition, the distilled spirits trade association, Distilled Spirits Council of the United States (DISCUS), was contacted for assistance in obtaining information about the industry and emissions.

To screen out unusable test reports, documents, and information from which emission factors could not be developed, the following general criteria were used:

1. Emission data must be from a primary reference:

a. Source testing must be from a referenced study that does not reiterate information from previous studies.

b. The document must constitute the original source of test data. For example, a technical paper was not included if the original study was contained in the previous document. If the exact source of the data could not be determined, the document was eliminated.

2. The referenced study should contain test results based on more than one test run. If results from only one run are presented, the emission factors must be down rated.

3. The report must contain sufficient data to evaluate the testing procedures and source operating conditions (e.g., one-page reports were generally rejected).

A final set of reference materials was compiled after a thorough review of the pertinent reports, documents, and information according to these criteria.

3.2 DATA QUALITY RATING SYSTEM[1]

As part of the analysis of the emission data, the quantity and quality of the information contained in the final set of reference documents were evaluated. The following data were excluded from consideration:

1. Test series averages reported in units that cannot be converted to the selected reporting units;

2. Test series representing incompatible test methods (i.e., comparison of EPA Method 5 front half with EPA Method 5 front and back half);

3. Test series of controlled emissions for which the control device is not specified;

4. Test series in which the source process is not clearly identified and described; and

5. Test series in which it is not clear whether the emissions were measured before or after the control device.

Test data sets that were not excluded were assigned a quality rating. The rating system used was that specified by EFIG for preparing AP-42 sections. The data were rated as follows:

A—Multiple test runs that were performed using sound methodology and reported in enough detail for adequate validation. These tests do not necessarily conform to the methodology specified in EPA reference test methods, although these methods were used as a guide for the methodology actually used.

B—Tests that were performed by a generally sound methodology but lack enough detail for adequate validation.

C—Tests that were based on an unproven or new methodology or that lacked a significant amount of background information.

D—Tests that were based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

The following criteria were used to evaluate source test reports for sound methodology and adequate detail:

1. Source operation. The manner in which the source was operated is well documented in the report. The source was operating within typical parameters during the test.

2. Sampling procedures. The sampling procedures conformed to a generally acceptable methodology. If actual procedures deviated from accepted methods, the deviations are well documented. When this occurred, an evaluation was made of the extent to which such alternative procedures could influence the test results.

3. Sampling and process data. Adequate sampling and process data are documented in the report, and any variations in the sampling and process operation are noted. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and are given a lower rating.

4. <u>Analysis and calculations</u>. The test reports contain original raw data sheets. The nomenclature and equations used were compared to those (if any) specified by EPA to establish equivalency. The depth of review of the calculations was dictated by the reviewer's confidence in the ability and conscientiousness of the tester, which in turn was based on factors such as consistency of results and completeness of other areas of the test report.

3.3 EMISSION FACTOR QUALITY RATING SYSTEM[1]

The quality of the emission factors developed from analysis of the test data was rated using the following general criteria:

<u>A—Excellent</u>: Developed from A- and B-rated source test data taken from many randomly chosen facilities in the industry population. The source category is specific enough so that variability within the source category population may be minimized.

<u>B—Above average</u>: Developed only from A- or B-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industries. The source category is specific enough so that variability within the source category population may be minimized.

<u>C—Average</u>: Developed only from A-, B- and/or C-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. In addition, the source category is specific enough so that variability within the source category population may be minimized.

<u>D—Below average</u>: The emission factor was developed only from A-, B-, and/or C-rated test data from a small number of facilities, and there is reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of the emission factor are noted in the emission factor table.

<u>E—Poor</u>: The emission factor was developed from C- and D-rated test data, and there is reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of these factors are footnoted.

The use of these criteria is somewhat subjective and depends to an extent upon the individual reviewer. Details of the rating of each candidate emission factor are provided in Section 4.

REFERENCE FOR SECTION 3

1. *Procedures for Preparing Emission Factor Documents*, Second Revised Draft Version, EPA-454/R-95-___, Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1995.

4. REVIEW OF SPECIFIC DATA SETS

4.1 INTRODUCTION

This section describes the data evaluated and methodology used to develop pollutant emission factors for the manufacture of distilled spirits. In general, the information presented in Section 9.12.3, Distilled Spirits, is new to Chapter 9 of AP-42. The section narrative presented in the current AP-42, Section 6.5 (Fourth Edition), only briefly discusses distilled spirits processes. In this new section, the distilled spirits production process is discussed with emphasis on the whisky-aging process and associated emissions.

4.2 REVIEW OF SPECIFIC DATA SETS

The literature search yielded two documents (References 1 and 2) from which emission factors could be developed. A review of these two documents is given below; full citations for these references are given at the end of this section. Pertinent excerpts from these references are provided in the Appendices. In addition, other references were identified in the literature search or by the industry.

4.2.1 Reference 1

This reference is a 1974 study of emissions from grain fermentation units at a U.S. whisky distillery. It consists of two parts: a 1974 journal article titled "Gaseous Emissions from Whisky Fermentation Units" and an undated preliminary paper with the same title and authors reporting the same data. The results provide the basis for a VOC emission factor from whisky fermentation tanks. Appendix A provides a copy of both references.

Emission source tests were conducted on four closed, steel fermentation vats at an unnamed integrated whisky distillery. Each vat held approximately 121,000 L (32,000 gal) of grain slurry, which yielded 5.14 proof gallons per bushel of grain. Chemical analysis indicated that fermentable sugars in the grain slurry were converted to CO_2, ethyl alcohol, and other VOCs; CO_2 and ethyl alcohol were produced in equivalent molecular quantities. Although carbon dioxide was the bulk constituent of the gas stream, ethyl alcohol and other VOCs also were emitted in the gas stream.

The tests were conducted by sealing off all effluent vents except for the emergency vent. Concurrent velocity and temperature measurements were taken at the emergency vent while sampling. Samples were collected by drawing headspace vapor through charcoal-filled glass tubes at 10-hour intervals. The charcoal sections were analyzed individually by extraction with carbon disulfide and injection into a gas chromatograph equipped with hydrogen flame ionization detectors. The chromatographic results detected six VOCs in the vat emissions; ethyl alcohol represented 99.6 percent of the total VOCs detected. The remaining compounds were: ethyl acetate, *n*-propyl alcohol, isobutyl alcohol, isoamyl acetate, and isoamyl alcohol. Isoamyl acetate and *n*-propyl alcohol were present in trace quantities and could not be quantified.

An emission factor based on quantity of emissions/quantity of grain fermented was developed. The authors' calculations were not given and, therefore, cannot be verified. The test was based on a new methodology conducted at one distillery and lacks sufficient data for confirmation of emission factors. This reference was given a rating of D.

4.2.2 Reference 2

Reference 2 is a 1978 EPA document which discusses the process by which alcohol is emitted from whisky barrels during aging and gives a detailed description of whisky warehouses and operations. Control technologies also are discussed, including ethanol capture and potential reuse, but it is recognized that the utilization of any control technology in a whisky aging warehouse potentially would have an adverse impact on product quality.

Four sets of data were used to estimate emission factors. The first set was U.S. Internal Revenue Service data;[c] distilleries report stocks, withdrawals, and losses to the BATF, which uses the data for taxation purposes. The data used were for the years 1974, 1975, and 1976. The emission factor derived from this data set includes both evaporation and soakage losses because the alcohol loss calculation is based on initial whisky stocks less withdrawals. The estimated emission factors range from 2.99 kg/bbl/yr (6.6 lb/bbl/yr) to 3.27 kg/bbl/yr (7.2 lb/bbl/yr) with an average of 3.15 kg/bbl/yr (6.9 lb/bbl/yr). This emission factor was calculated by subtracting the amount of distilled spirits taken from storage for consumption from the original amount of distilled spirits stored. The other three data sets were from individual distillers, emissions from whisky in bonded warehouses, and losses based on age distribution of bonded whisky in Kentucky in 1975. The emission factor developed from the individual distillers data set was 3.65 kg/bbl/yr (8.0 lb/bbl/yr). For emissions from whisky in bonded warehouses, the emission factor was 3.02 kg/bbl/yr (6.6 lb/bbl/yr). The emission factor developed based on the age distribution data was 3.46 kg/bbl/yr (7.6 lb/bbl/yr). The average emission factor based the three data sets was 3.38 kg/bbl/yr (7.4 lb/bbl/yr). This emission factor includes both evaporative losses and losses due to soakage.

The original calculations for this reference were not available to review. The data were rated D. Pertinent excerpts from the reference are presented in Appendix B.

4.2.3 Reference 3

Reference 3 is a 1992 letter from the Commonwealth of Kentucky adopting an ethanol evaporative emission factor of 7.6 lb/bbl/yr for the aging process. This value was based upon information received from EPA based on Reference 2. Because the emission factor was based on the same data presented in Reference 2, this reference was not used in Section 4.3.2. Reference 3 does not contain actual emission measurements for the industry and is graded D. Appendix C contains a copy of Reference 3.

4.2.4 Reference 4

This report discusses a waste minimization assessment for an unidentified Bourbon distillery that annually produces approximately 5 million gallons of Bourbon and 16,000 tons of distillers dried grains. Annual ethanol emissions (lb/yr) were estimated for five different emission sources but no information was presented for the method used to estimate these emission levels. No descriptions of the production process or any details of the emissions were provided because of facility confidentiality issues.

The data quality are rated D. No data from this reference were used to develop emission factors. An EPA research brief and report cover page are provided in Appendix D.

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[c]The reference refers to these as IRS data, although the publication cited was the Bureau of Alcohol, Tobacco, and Firearms (BATF), U.S. Treasury Department.

4.2.5 <u>Reference 5</u>

Reference 5 is a compilation of regauged tax gallon (RTG) data over a series of aging periods for Bourbon, corn whisky, and light whisky developed by Seagram Americas. The data represent measured whisky volumes (in proof gallons) from barrels after varying stages of the aging process. Based on these data, average total ethanol losses were calculated over an aging time between 4 and 10.5 years for each of the three types of whisky. The average total ethanol losses include both evaporation losses and soakage losses. Calculated total ethanol losses were 3.3 kg/bbl/yr (7.3 lb/bbl/yr) for Bourbon, 3.1 kg/bbl/yr (6.8 lb/bbl/yr) for corn, and 3.9 kg/bbl/yr (8.5 lb/bbl/yr) for light whisky; the average total ethanol loss for the three types is 3.4 kg/bbl/yr (7.5 lb/bbl/yr).

Soakage losses were calculated for each of the three types based on the reported data; the soakage value for Bourbon was confirmed by Seagrams based on actual weight measurements. The average total proof gallon loss, excluding soakage, should be an estimate of losses due to evaporation. The average total ethanol losses due to evaporation were 2.7 kg/bbl/yr (6.0 lb/bbl/yr) for Bourbon, 3.0 kg/bbl/yr (6.5 lb/bbl/yr) for corn, and 3.7 kg/bbl/yr (8.2 lb/bbl/yr) for light whisky; for the three types, the average total ethanol loss due to evaporation is 3.1 kg/bbl/yr (6.9 lb/bbl/yr).

The original data and calculations for this reference were not available to review. The data were rated D. Appendix E contains the data submitted by Seagram Americas and the pertinent calculations for this reference.

4.2.6 <u>Reference 6</u>

Reference 6 is a compilation of whisky loss data over a series of aging periods for Bourbon and corn whisky developed by Jim Beam Brands. The data represent measured whisky losses determined as the difference between proof gallons (PG) entered minus the proof gallons regauged for tax purposes when emptied. Based on these data, average total ethanol losses were calculated over an aging time between 4.7 and 10.5 years for Bourbon whisky and 3.9 and 8.4 years for corn whisky. The average total ethanol losses include both evaporation losses and soakage losses. Calculated total ethanol losses were 4.2 kg/bbl-yr (9.3 lb/bbl/yr) for Bourbon and 3.4 kg/bbl/yr (7.5 lb/bbl/yr) for corn whisky; the average total ethanol loss for the two types is 3.8 kg/bbl/yr (8.4 lb/bbl/yr).

Soakage loss for Bourbon was calculated based on the reported data. The average total PG loss, excluding soakage, should be an estimate of losses due to evaporation. For Bourbon whisky, the total ethanol loss due to evaporation was 3.1 kg/bbl/yr (6.8 lb/bbl/yr).

The original data and calculations for this reference were not available to review. The data were rated D. Appendix F contains the data submitted by Jim Beam Brands and the pertinent calculations for this reference.

4.3 DEVELOPMENT OF CANDIDATE EMISSION FACTORS

Candidate emission factors for the fermentation and for aging are developed below. An alternative estimation method for losses during aging is also presented. No data were available for ethanol or VOC emissions from any source other than fermentation and aging. No data were available for particulate (PM) emissions from grain receiving, handling, cleaning, and milling, and dryer house operations. Emission

factors for grain receiving, handling, and cleaning may be found in AP-42 Section 9.9.1, Grain Elevators and Processes.

4.3.1 <u>Whisky Fermentation</u>

The candidate emission factors for four VOCs in whisky fermentation vats (Table 4-1) were taken directly from Reference 1. Distillers report that bushel weights may vary between distilled spirits operations therefore introducing a potential source of error in the application of the emission factor. Because the emission factor was based upon D-rated test data, the emission factor is rated E.

TABLE 4-1. EMISSION FACTORS FOR WHISKY
FERMENTATION VATS

EMISSION FACTOR RATING: E

VOC	Emission factor	
	g/m^3 (ppm)	lb/1,000 bu grain input
Ethyl acetate	0.59	0.046
Ethyl alcohol	182.2	14.15
Isobutyl alcohol	0.051	0.004
Isoamyl alcohol	0.17	0.013
Total VOCs	183	14.21

Source: Reference 1 (see Appendix A).

4.3.2 <u>Whisky Aging</u>

A summary of references 2, 5, and 6 for ethanol emissions during the whisky aging process is shown in Table 4-2. Full citations for these references are given at the end of this section. Pertinent excerpts from these references are provided in the Appendices B, E, and F. References 3 and 4 did not contain appropriate emissions data and were not used for emission factor development.

An average ethanol emission factor for total losses during whisky aging was calculated based on the four data sources cited in Table 4-2. The candidate emission factor for total ethanol loss during whisky aging is 3.45 kg/bbl/yr (7.6 lb/bbl/yr). Because the emission factor was based upon D-rated test data, the emission factor is rated E.

An average ethanol emission factor for evaporation losses (total losses minus soakage) during whisky aging was calculated based on the two data sources cited in Table 4-2. The candidate emission factor for ethanol evaporation loss during whisky aging is 3.1 kg/bbl/yr (6.9 lb/bbl/yr). Because the emission factor was based upon D-rated test data, the emission factor is rated E.

TABLE 4-2. SUMMARY OF ETHANOL EMISSION DATA FOR WHISKY AGING

Source	Type of loss	No. of data sets	Data rating	Emission factor range, kg/bbl/yr (lb/bbl/yr)	Average emission factor, kg/bbl/yr (lb/bbl/yr)	Ref. No.
BATF reports	Total[a]	3	D	3.0-3.3 (6.6-7.2)	3.2 (6.9)	2
Distillery data	Total	3	D	3.0-3.7-(6.6-8.0)	3.4 (7.4)	2
Seagrams America	Total Evaporation[b]	3 3	D D	3.1-3.9 (6.8-8.5) 2.7-3.7 (6.0-8.2)	3.4 (7.5) 3.1 (6.9)	5 5
Jim Beam Brands	Total Evaporation	2 1	D D	3.4-4.2 (7.5-9.3) NA	3.8 (8.4) 3.1 (6.8)	6 6

[a]Total loss incorporates all losses including soakage.
[b]Evaporation loss is defined as total loss minus soakage loss.

Alternatively an ethanol emission factor for total losses during aging and for evaporative losses can be calculated based on annual emissions per barrel in proof gallons (PG). This calculation method is derived from the gauging of product that a distiller is required to perform by the federal government for federal revenue protection purposes. This method measures the difference in the amount of product when the barrel was filled and when the barrel was emptied. Fugitive evaporative emissions, however, are not the sole difference between these two amounts. During the aging period, product soaks into the barrel, test samples are drawn, and other losses (e.g., spillage, leakage) may occur. Soakage only applies to new barrels. Soakage and other losses not volatilized are not evaporative emissions, and thus are subtracted from total product losses. Average annual ethanol emissions per barrel per year is obtained as follows:

1. Divide the total annual proof gallons (PG) sent to aging by the number of barrels filled to obtain the original PG per barrel;

2. Divide the total annual PG emptied by the number of barrels emptied to give regauged PG, which is the amount of ethanol recovered after the entire aging process;

3. Subtract the regauged PG from the original PG to give the total quantity of ethanol per barrel lost (TQL) during the aging process;

4. Total ethanol evaporative emissions, in PG, are obtained by adjusting the TQL for non-volatilized losses such as soakage and samples withdrawn for quality control; and

5. Total evaporative emissions are divided by the number of years of aging to obtain the average annual evaporative emissions, in PG, per barrel.

The annual emissions in proof gallons are then converted to pounds of ethanol per barrel per aging year by dividing by two (2) and multiplying by 6.6097 lb per gallon for 100 percent ethanol at 15.6°C (60°F).

There are a number of methods to calculate barrel soakage. Soakage is the ethanol that soaks into and saturates the new barrel wood during the aging process. This ethanol is retained in the barrel wood when the product is emptied from the barrel and will only be released to the atmosphere at a source if the

barrel is not reused within a reasonable period of time. Since barrels generally are put back into service immediately for aging various other products, the differences in losses between new Bourbon barrels and reused barrels can closely approximate the amount of soakage that occurs during the life of a barrel. One estimation method involves determining total ethanol losses per barrel, based on steps 1 through 5 above, for new and reused barrels. For new barrels, total ethanol losses include soakage losses but not for reused barrels. The difference between total ethanol losses for new barrels and for reused barrels can be used as an estimate of soakage losses. With this method, it is important that entry proofs of both new and used barrels be close to the same strength and that the barrels are stored under similar warehouse conditions. There is no exclusive method to calculate soakage and factors such as entry proof, individual barrel characteristics, differences in the water content of the wood, and differences in aging practices, can impact the amount of soakage. In addition, the method for estimating soakage may differ between distillers.

4.4 SUMMARY OF CHANGES TO AP-42 SECTION

4.4.1 Section Narrative

The previous AP-42 section incorporated distilled spirits production into an overall section entitled "Fermentation" but no process description or process flow diagram was provided. This new section provides a description of the current production practices and a process flow diagram for a typical whisky production facility.

4.4.2 Emission Factors

The previous AP-42 section presented emission factors based on outdated production processes. This new section replaces the existing emission factors with data consistent with current practices in the distilled spirits industry.

REFERENCES FOR SECTION 4

1. Carter, R. V., and B. Linsky, "Gaseous Emissions from Whiskey Fermentation Units," *Atmospheric Environment*, 8:57-62, January 1974; also a preliminary paper of the same title by these authors (undated).

2. *Cost and Engineering Study-Control of Volatile Organic Emissions from Whiskey Warehousing*, EPA-450/2-78-013, Emissions Standards Division, Chemical and Petroleum Branch, Office of Air Quality Planning and Standards, U. S. EPA, Research Triangle Park, NC, April 1978.

3. Written communication from J. E. Hornback, Department For Environmental Protection, Commonwealth of Kentucky, Frankfort, KY, to H. E. O'Daniel, Jr., Kentucky Distillers Association, Springfield, KY, September 18, 1992.

4. Fleischman, M., et al., "Waste Minimization Assessment to a Bourbon Distillery", EPA/600/5-95/002, Risk Reduction Engineering Laboratory, U. S. Environmental Protection Agency, Cincinnati, OH, April 1995.

5. Written communication from R. J. Garcia, Seagrams Americas, Louisville, KY, to T. Lapp, Midwest Research Institute, Cary, NC, March 3, 1997. RTG's versus age for 1993 standards.

6. Written communication from L. J. Omlie, Distilled Spirits Council of the United States, Washington, DC, to T. Lapp, Midwest Research Institute, Cary, NC, February 6, 1997. Ethanol emissions data from Jim Beam Brands Company.

Appendix A5: February 10, 1999; EPA Policy
Memo, "Interpretation of the Definition of Fugitive
Emissions in Parts 70 and 71"

February 10, 1999

MEMORANDUM

SUBJECT: Interpretation of the Definition of Fugitive Emissions
           in Parts 70 and 71

FROM: Thomas C. Curran, Director   /s/
           Information Transfer and Program
              Integration Division (MD-12)

TO: Judith M. Katz, Director
           Air Protection Division, Region III (3AT00)

     This is in response to your memorandum of August 8, 1997 and
subsequent discussions regarding the definition of "fugitive
emissions." Specifically, you asked how this definition applies
to the emissions of volatile organic compounds (VOC) from the
printing industry, whiskey warehouses, paint manufacturing
facilities, and other similar sources for purposes of title V.
The delay in getting back to you was principally due to extensive
consultation as needed among the various Headquarters and
Regional Offices and has resulted in more technically and legally
supportable policy.

     When counting emissions to determine if a source exceeds the
major source thresholds under title V (parts 70 and 71),
nonfugitive VOC emissions are always counted. Fugitive VOC
emissions, however, are counted only in certain circumstances.
Because of this, the determination of whether emissions are
fugitive or nonfugitive can be critically important for major
source determinations under title V.

     The EPA defines "fugitive emissions" in the regulations
promulgated under title V as "those emissions which could not
reasonably pass through a stack, chimney, vent, or other
functionally-equivalent opening" (see title 40 of the Code of
Federal Regulations, sections 70.2 and 71.2). This definition is
identical to the definition of "fugitive emissions" adopted by
EPA in the regulations implementing the new source review (NSR)

program. Given this, the precedents established in the NSR
program should be relied on in interpreting the definition of
"fugitive emissions" for purposes of title V.

In 1987 and again in 1994, EPA issued guidance regarding the
classification of emissions from landfills for NSR applicability
purposes.[1] In these guidance memorandums, EPA made clear that
emissions which *are actually collected* are not fugitive
emissions. Thus, for example, when a source is subject to a
national standard requiring collection of emissions, these
emissions cannot be considered fugitive. Whether or not a source
is subject to such a national standard, emissions which pass
through a stack, chimney, vent, or other functionally-equivalent
opening are not fugitive.

Where emissions are not actually collected at a particular
site, the question of whether the emissions are fugitive or
nonfugitive should be based on a factual, case-by-case
determination made by the permitting authority. As noted in
EPA's 1994 guidance,

> In determining whether emissions could reasonably be
> collected (or if any emissions source could reasonably
> pass through a stack, etc.), "reasonableness" should be
> construed broadly. The existence of collection
> technology in use by other sources in a source category
> creates a presumption that collection is reasonable.
> Furthermore, in certain circumstances, the collection
> of emissions from a specific pollutant emitting
> activity can create a presumption that collection is
> reasonable for a similar pollutant-emitting activity,
> even if that activity is located within a different
> source category.

Based on the above principles, EPA believes it appropriate
to presume that VOC emissions from the printing industry and
paint manufacturers could reasonably be collected and thus are

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[1] See memorandums entitled "Classification of Emissions from
Landfills for NSR Applicability Purposes" from John S. Seitz,
Office of Air Quality Planning and Standards, to Air Division
Directors, Regions I-X, dated October 21, 1994, and "Emissions
from Landfills" from Gerald A. Emison, Director, Office of Air
Quality Planning and Standards, to David P. Howekamp, Director,
Air Management Division, Region IX, dated October 6, 1987.

not fugitive. In addition, unless this presumption is rebutted by the source, such emissions should be counted in major source determinations.

We have reached this conclusion for printers and paint manufacturers because certain printers are subject to national standards and State implementation plan (SIP) requirements (e.g., reasonably achievable control technology, best available control technology, or lowest achievable emissions rate) requiring collection. Moreover, sources in both of these source categories commonly employ collection devices. The common use of collection technology by other printing and paint manufacturing sources creates a presumption that collection of emissions is reasonable at other similar sources.

In the case of whiskey warehouses, the presumption that emissions could reasonably be collected is less compelling and may warrant further consideration by States in consultation with the EPA Regional Offices. For example, we are not aware of any national standards or SIP requirements for the collection of VOC emissions from whiskey warehouses, and we believe it is uncommon for them to have voluntarily installed collection devices. On the other hand, EPA is aware of warehouses in other source categories that collect emissions and thus a presumption is created that whiskey warehouse emissions could reasonably be collected. In addition, in a factual determination for a whiskey warehouse in the State of Indiana, EPA Region V found, after careful review, that the emissions of the warehouse were not fugitive.

In addition, you ask whether costs should be a factor used to determine if emissions can be reasonably collected. Obviously, when emissions are actually collected, cost considerations are irrelevant to determine whether emissions are fugitive. On the other hand, when a source does not actually collect its emissions, but there is a presumption that collection would be reasonable, a permitting authority could consider costs in determining whether this presumption is correct. However, when analyzing whether collection is reasonable for a particular source, the permitting authority should not focus solely on cost factors, nor should cost factors be given any more weight than other factors. Instead, the permitting authority should focus on determining whether a particular source is truly similar to the "similar sources" used to create the presumption. This determination can be made by looking at whether there are substantial differences in the technical or engineering characteristics of the sources. In this stage of the analysis, a comparison of the costs of collecting emissions could be relevant

where it illustrates the underlying technical or engineering differences. Moreover, keep in mind that title V does not impose any requirements on subject sources to collect (or control) their emissions and that collection is only assumed for the purpose of determining title V applicability. Thus, no source will ever be required to incur the costs of installing, operating, or maintaining collection devices (or control devices) because of a presumption that its emissions are not fugitive or subsequently because it is found to be subject to title V.

The approach for interpreting the definition of fugitive emissions outlined in this memorandum is consistent with the approach used historically by Headquarters, as well as the majority of EPA Regions and States. We believe, therefore, that the impact of this memorandum will be limited, both in the number of sources for which reclassification of emissions from fugitive to nonfugitive may be required, and to a greater extent, in the number of sources subject to reclassification from minor to major source.

We recognize that this interpretation may present enforcement issues for an unknown (but presumably small) number of sources whose initial title V applicability determinations were overly broad with respect to which emissions they have interpreted as being fugitive. Therefore, EPA recommends that the following steps be taken. If the policies of an EPA Region or State for interpreting the definition of fugitive emissions are consistent with the policies described in this memorandum, then the EPA Region or State should continue to enforce its policies as it has in the past. However, if the policies of an EPA Region or State have not been as inclusive as the policies described in this memorandum, then major sources that have not applied for operating permits on the basis of these less-inclusive policies should be instructed to immediately notify the State and EPA Region in writing of their obligation to obtain a title V permit. Such sources should be instructed to prepare and submit permit applications to the appropriate permitting authority as expeditiously as possible.

The EPA will use its enforcement discretion in deciding whether or not to seek an enforcement action against sources for failure to obtain an operating permit. However, factors that may be considered in deciding whether to seek enforcement action against sources may include whether the sources relied on less inclusive policies of a State or EPA Region and whether the sources expeditiously submit permit applications after they become aware of the national policy described in this memorandum.

        If you have any questions, please contact Steve Hitte at
919-541-0886 or Jeff Herring at 919-541-3195 of the Operating
Permits Group.

cc: Director, Office of Ecosystem Protection, Region I
     Director, Division of Environmental Planning and Protection,
       Region II
     Director, Air, Pesticides, and Toxics Management Division,
       Region IV
     Director, Air and Radiation Division, Region V
     Director, Multimedia Planning and Permitting Division,
       Region VI
     Director, Air, RCRA, and Toxics Division, Region VII
     Assistant Regional Administrator, Office of Partnership and
       Regulatory Assistance, Region VIII
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 2 3 2000

OFFICE OF
AIR AND RADIATION

The Honorable Robert C. Smith
Chairman, Committee on Environment
& Public Works
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

This letter is in response to your question as to whether the Environmental Protection Agency (EPA) has identified reasonably available control technology (RACT) for ethanol emissions from alcohol beverage aging warehouses. One control technology which has been suggested in this regard is carbon adsorption which conceivably could be applied to the warehouse ventilation exhaust to capture ethanol fumes. However, in order to capture the warehouse fumes it may be necessary to modify the air flowing through the warehouse which could affect temperature, humidity and ventilation in the warehouse. The industry has raised questions about whether these changes would adversely affect the product quality.

Due to this unresolved issue, EPA has not, at this time, declared that such add-on control devices are RACT for alcohol beverage aging warehouses. Nor has EPA currently identified any other available technology which it considers to be RACT for alcohol beverage aging warehouses. Therefore, EPA is not requiring states to control these sources in order to meet ozone control state implementation plan requirements.

I appreciate this opportunity to be of service and trust that this information will be helpful to you.

Sincerely,

John C. Beale
Deputy Assistant Administrator
for Air and Radiation

cc: The Honorable Max Baucus

MDE **Technical Support Document**

**CONTROL OF VOLATILE ORGANIC COMPOUNDS FROM
DISTILLED SPIRITS FACILITIES
COMAR 26.11.19.29**

I.   INTRODUCTION

The purpose of this document is to provide support for the Department's Reasonably Available Control Technology (RACT) determination for the control of volatile organic compounds (VOCs) from distilled spirits facilities. Distilled spirits facilities have been identified as major VOC sources and therefore are required by the Federal Clean Air Act to comply with RACT. These facilities receive bulk liquor by train or tank truck, transfer some of it into wood barrels to age, and then bottle the aged liquor. The aging process is the primary source of VOC emissions which are mostly ethanol, a VOC, with trace amounts of acetaldehyde, a potential human carcinogen. The VOC from the aging operation is released as fugitive emissions and is caused by the breathing of the barrels. The reaction within the barrel and the breathing are a part of the aging cycle. Interference with the breathing of the barrels or changing the airflow interfere with the product quality.

The storage temperature for the barrels during the aging process is important in determining evaporative losses. The large multi-story buildings where barrels are stored for the aging process and some working areas such as the transfer areas are not completely enclosed and do not have temperature controls or forced ventilation.   As a result, large volumes of air with low VOC concentrations are vented from these areas. Use of conventional air pollution control devices to treat the large volumes of air with a low VOC concentration would not be cost effective.

The primary objective of this RACT regulation is to require good operating practices to minimize fugitive emissions.

II.   AFFECTED INDUSTRY IN MARYLAND

The regulation will apply to distilled spirits facilities that have a potential to emit 25 tons of VOC or more per year. Although the liquor production industry in Maryland was significant several years ago, there is only one major source remaining.   Seagram Americas, located in Baltimore

"Together We Can Clean Up"

County, has the only commercial aging warehouse currently operating in Maryland. During the past few years, the facility has downsized considerably. It does not manufacture or distill liquor on the premises, and has significantly reduced the total number of barrels being aged on location. The facility typically operates only one shift a day, five days a week and currently has a throughput of less than 10 million proof gallons a year (a proof gallon is a liquid measure that means 1 gallon of proof alcohol).

III.   SOURCE DESCRIPTION AND EMISSION POINTS

The Seagram facility receives distilled spirits in bulk, by truck and rail. The facility processes a variety of beverages including rums, gins, whiskeys and small amounts of specialty products, including non-alcoholic beverages.

Incoming materials are stored in bulk and then some of them are dispensed into barrels for aging. After aging for a period ranging from several months to several years, products are blended, filtered and bottled, and packaged in boxes, and shipped for distribution. Emissions result from the dispensing into and from the barrels, from empty used barrels, and from the filtering operations.

The facility has approximately 200 storage tanks, with sizes ranging from less than 600 to 500,000 gallons that are used to store incoming material and for occasional blending prior to aging. The tanks are used to store and process incoming materials. Most of the tanks are equipped with conservation vents and flame arresters, and are mostly located inside buildings.

The affected facility currently ages rum in warehouses using oak barrels that are sealed and stacked from floor to ceiling. When the aging cycle is complete, the oak barrels are emptied, the product recovered and the barrel inspected for possible reuse. Barrels are usually used up to an average of 5 storage cycles depending on the product being aged. The company is investigating alternative methods for filling, emptying and storing the barrels.

All oak barrels have a charred interior surface. During the aging process the distilled spirits react with the charred wood, creating a continuous mass transfer/exchange process that provides the beverage with color, flavor and organic compounds extracted from the wood. These extracted compounds are very important as they affect the quality of the final product. During the aging process, water and ethanol are absorbed by the wood. Once it is saturated, part of the water and alcohol permeates through the barrels into the warehouse air. Unacceptable product quality resulted from the use of metal barrels with charred chips of wood. This was tested as an alternative to the traditional oak barrels.

The warehouse environment, humidity, temperature, air movement and pressure are believed to be the driving forces of the evaporative process. In order to minimize evaporative losses the company has experimented with various operational control techniques. Efforts to confine or

control the environmental conditions have not been very successful and are very expensive due to the size of the warehouses. Experiences in Kentucky with changing the storage environment have resulted in products with unacceptable quality. Best results seem to be achieved when utilizing natural air convection in the warehouses..
.

IV.   REGULATION SUMMARY

This regulation applies to a facility that has the potential to emit 25 tons or more of VOC per year. The regulation requires the following:

(1)   The modification of the barrel emptying operations through the use of suction devices that minimize VOC evaporative losses.

(2)   The use of an enclosed system for the drainage of distilled spirits from the filtering operations.

(3)   The use of gravity and vacuum or pressure filling system in the bottling area.

(4)   Limits on the storage of empty used barrels stored in the outdoors.

(5)   The submission of a good operating practices manual for the Department's approval.

The following is a brief explanation of each of the regulatory requirements.

A.   Modification of the Barrel Filling and Emptying Operations

Seagrams utilizes one warehouse, Building 16, to perform the barrel emptying and filling operations. Currently the barrels have a lateral plug or bung. At this location, they are de-bunged, titled and drained of the product by gravity into a large collecting pan. The product is then pumped into an intermediate storage tank. The process is long and allows considerable evaporation of a portion of the liquids.

The regulation will require the use of bayonet type suction devices for barrel emptying. The barrels are emptied by inserting a bayonet type suction device through the bung opening in the barrel. The product is then transferred by pump directly to the storage tank. Immediately after, the pallet is rotated to an adjacent station and inspected. The barrels are then refilled using a system similar to the one used to dispense gasoline into a motor vehicle. The barrels are then plugged and transported to the warehouse for the next aging cycle.

The new system eliminates the product evaporation losses from the use of open troughs. The company achieved full use of this procedure in 1997.

B.   Use of an Enclosed Collection System for the Drainage of Distilled Spirits

Plate and frame filters are used for final filtering operations to remove trace impurities prior to bottling. Currently eleven filtering systems are used. Some have a shallow collecting pan to contain drippings from normal plate and frame filter operations. Evaporation occurs from the open surface area of the pan. In order to minimize these emissions, the regulation requires the collection of the product drippings by means of an enclosed system. This would include pumping collected material from the pans to an enclosed vessel or draining drippings to an enclosed sewer.

C.   Use of Gravity and Vacuum or Pressure Operated Filling System in the Bottling Area

The facility has 10 bottling lines that dispense the final product into various size bottles. Bottling lines will be required to use automated systems. The automated systems will reduce fugitive VOC emissions from the displacement of the air in the bottles as the bottles are filled. The bottles are filled prior to the saturation of displaced air.

D.   Limits on Outdoor Storage of Empty Used Barrels

Used barrels are sometimes stored in outside areas. The outside exposure of barrels containing residual distilled products to sunlight generates VOC emissions. Prior to the conversion to the palletized system, several thousand empty barrels were routinely stored outside waiting to be filled. Even the "new" barrels at this facility have previously been used at other out-of-state facilities and therefore contribute to the facility's fugitive VOC emissions when stored outside.

The regulation requires the barrels stored outside to be quenched periodically with water to reduce leaking.

E.   Submission of a Good Operating Practices Manual

The affected source will evaluate additional methods of reducing emissions such as minimizing evaporation of ethanol from spills during the packaging operation. The affected source is required to submit a proposal where additional fugitive reductions can be achieved by process changes, housekeeping modifications or implementing pollution prevention measures.

V.   AIR QUALITY BENEFITS AND ECONOMIC IMPACT

Emission Reductions

Based on recent studies performed by the source, it is estimated that over 90 percent of the source's VOC emissions are fugitive. Total VOC emissions for 1990 were 265 tons a year. Current emissions are approximately 235 tons a year. Further reductions are anticipated when good operating practices are implemented.

Economic Impact

Capital costs for plant improvements to date exceed $ 200,000. The total annual operating costs to implement good operating practices as they apply to filter presses and empty barrel storage are $ 8,000.

VI.   OTHER STATE AND FEDERAL REGULATIONS THAT APPLY TO THIS SOURCE CATEGORY

Very few states have addressed VOC emissions from aging warehouses. Kentucky issued special permits for distilleries located in the State that require minimal reductions of fugitive emissions. The Federal Clean Air Act requires major Sources of VOC or NOx to be subject to and comply with RACT.

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Appendix A8: August 4, 2004; Indiana Office of Environmental Adjudication Findings of Fact, Conclusions of Law, and Final Order Regarding Aging Warehouse Fugitive Emissions

☑002/009

INDIANA OFFICE OF ENVIRONMENTAL ADJUDICATION

Mary Davidsen
Chief Environmental Law Judge

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STATE OF INDIANA	)	BEFORE THE INDIANA OFFICE OF
	)	ENVIRONMENTAL ADJUDICATION
COUNTY OF MARION	)	
IN THE MATTER OF:	)	
	)	
OBJECTION TO THE ISSUANCE OF	)	
PART 70 OPERATING PERMIT	)	
NO. T-137-6928-00011 FOR	)	CAUSE NO. 03-A-J-3003
JOSEPH E. SEAGRAM & SONS, INC.	)	
RIPLEY COUNTY, IN	)	

FINDINGS OF FACT, CONCLUSIONS OF LAW AND FINAL ORDER

This matter having come before the Court on the Motion for Summary Judgment filed by the Indiana Department of Environmental Management (the "IDEM") and on the Cross Motion for Summary Judgment filed by Joseph E. Seagram & Sons, Inc. (the "Petitioner"), which pleadings are a part of the Court's record; and the Environmental Law Judge ("ELJ") having read and considered the petitions, motions, record of proceedings, evidence, and the briefs, responses and replies of the parties, now finds that judgment may be made upon the record; and the ELJ, by a preponderance of the evidence and being duly advised, now makes the following findings of fact and conclusions of law and enters the following Order:

FINDINGS OF FACT

1. Findings of fact that may be construed as conclusions of law and conclusions of law that may be construed as findings of fact are so deemed.

2. The IDEM issued Part 70 Operating Permit No. T-137-6928-00011 to the Petitioner on December 23, 2002 for the facility located on Highway 350 West, Milan, Indiana (the "Facility").

3. The Petitioner filed its Petition for Review on January 22, 2004. This Petition is timely filed.

4. IDEM filed its Motion for Summary Judgment on February 26, 2004. The Petitioner filed Seagram's Response to IDEM's Motion for Summary Judgment and Seagram's Cross-Motion for Summary Judgment on April 19, 2004.

5. Pursuant to Stipulations of Fact filed by IDEM on February 26, 2004, the only issue before this Court is whether this Facility is a major source under the regulations in 40 CFR Part 70 and therefore, requires an Part 70 operating permit.

6. It is undisputed by the parties that:
   a   The Facility consists of 10 whiskey warehouses used to store whiskey in barrels for aging.
   b.   Ventilation in the warehouse is provided by 17 inch by 48 inch screen-covered openings along the bottom of the warehouse walls.
   c.   The Facility relies on natural ventilation and does not use fans to force air in or out of the warehouse.
   d.   The Facility emits over 100 tons per year (tpy) ethanol emissions. Ethanol is a regulated volatile organic compound (VOC).

7. In addition, this Court finds:
   a.   The warehouses are not heated or cooled. Temperature and humidity inside the warehouses follow the outside environment.
   b.   Throughout the course of the year, the wind direction and speed change considerably, resulting in constantly changing ventilation rate and conditions. Air may enter, or ethanol emissions and air may exit, the same opening, depending on which way the wind is blowing at any given time.
   c.   The barrel environment is critical in whiskey aging. Ambient atmospheric conditions, such as seasonal variation in temperature and humidity, have a great effect on the aging process. The equilibrium concentrations of the various whiskey components depend heavily on the airflow around the barrel. Each distiller depends upon these variables to produce its distinctive brand with its own taste, color, and aroma. United States Environmental Protection Agency (US EPA) Emission Factor Documentation for AP-42, Section 9.12.3 Distilled Spirits, Final Report (March 1997). Affidavit of William M. Burch, Exhibit A to Seagram's Response to IDEM's Motion for Summary Judgment and Seagram's Cross-Motion for Summary Judgment.
   d.   The only full scale test reported in the literature in which whiskey warehouse emissions were collected for air pollution control purposes was an experiment with carbon adsorption described in EPA's 1978 *Cost and Engineering Study Control of Volatile Organic Emissions for Whiskey Warehousing (supra* at n. 3). The report concluded:

> The cost problems discussed above and the failure of the full-scale test show that control of emissions from whiskey warehousing has not been demonstrated at this time.

EPA *Cost and Engineering Study* at p. 1-4; *see also id.* at p. 4-14. In both the 1978 *Cost and Engineering Study* and again in its consideration of pollution control technology for New Source Performance Standards for storage vessels, EPA concluded that available emission control technology "could contaminate beverage alcohol resulting in a produce with little or no market value." 52 Fed.Reg. 11420, 11424 (Apr. 8, 1987).

e.　　No whiskey aging facility in the United States controls ethanol emissions. Affidavit of William M. Burch, Exhibit A to Seagram's Response to IDEM's Motion for Summary Judgment and Seagram's Cross-Motion for Summary Judgment.

f.　　As of October 23, 2000, the U.S. EPA had not identified any reasonably available control technology (RACT) for ethanol emissions from alcohol beverage aging warehouses. · U.S. EPA letter to Senator Robert C. Smith, Chairman of the Senate Committee on Environment and Public Works, page 1 (October 23, 2000), Exhibit J to Seagram's Response to IDEM's Motion for Summary Judgment and Seagram's Cross-Motion for Summary Judgment.

f.　　Collecting and controlling emissions from whiskey aging facilities is generally considered incompatible with maintaining product quality. Affidavit of William M. Burch, Exhibit A to Seagram's Response to IDEM's Motion for Summary Judgment and Seagram's Cross-Motion for Summary Judgment.

8. The VOC emissions from the Facility are fugitive emissions.

CONCLUSIONS OF LAW

1. The Office of Environmental Adjudication ("OEA") has jurisdiction over the decisions of the Commissioner of the IDEM and the parties to the controversy pursuant to IC 4-21.5-7-3.

2. A facility is a major source under the Clean Air Act if it emits more than 100 tpy VOCs, *excluding fugitive emissions*, 326 IAC 2-7-1(22)(B). The critical issue in determining whether this Facility is a major source is whether the VOC emissions are "fugitive emissions" as defined by 40 CFR § 70.2 and 326 IAC 2-7-1(18). "Fugitive emissions" are defined as "emissions which could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening." The initial question is how should this definition be construed? Neither the IDEM nor the Petitioner have cited to any binding precedent regarding the statutory construction of this regulation.

3. The same rules that govern construction of statutes also govern construction of rules. As the court stated in *Miller Brewing Co. v. Bartholomew County Beverage Cos., Inc.*, 674 N.E.2d 193 (Ind. Ct. App. 1996):

> Our inquiry into the meaning of Rule 28's prohibition ... begins with a recognition that rules which apply to the construction of statutes also apply to the construction of administrative rules and regulations. *Indiana Dep't of Natural Resources v. Peabody Coal Co.* (1995) Ind. App., 654 N.E.2d 289. Of course, properly adopted administrative rules and regulations have the force and effect of law. *Dep't of Fin. Inst. v. Johnson Chev. Co.* (1950) 228 Ind. 397, 92 N.E.2d 714.

4. The rules of statutory construction state, "If a statute is subject to interpretation, our main objectives are to determine, effect, and implement the intent of the legislature in such a

manner so as to prevent absurdity and hardship and to favor public convenience." *State v. Evans*, 790 N.E.2d 558, 560 (Ind. App., 2003).

5. The appellate courts in Indiana consistently hold that an agency's interpretation of a statute is entitled to deference. The Court in *Shaffer v. State*, 795 N.E.2d 1072, 1076 (Ind.Ct.App. 2003) stated, "When a statute is subject to different interpretations, the interpretation of the statute by the administrative agency charged with the duty of enforcing the statute is entitled to great weight, unless that interpretation is inconsistent with the statute itself."

6. U.S EPA's interpretation of its own regulations is entitled to controlling weight. The Supreme Court has articulated the following principle of judicial deference to a consistent, longstanding interpretation of an agency's own rules by its highest officials:

> We must give substantial deference to an agency's interpretation of its own regulations. *Martin v. Occupational Safety and Health Review Comm'n*, 499 U.S. 144, 150-151, 111 S.Ct. 1171, 1175-1176, 113 L.Ed.2d 117 (1991); *Lyng v. Payne*, 476 U.S. 926, 939, 106 S.Ct. 2333, 2341, 90 L.Ed.2d 921 (1986); *Udall v. Tallman*, 380 U.S. 1, 16, 85 S.Ct. 792, 801, 13 L.Ed.2d 616(1965). Our task is not to decide which among several competing interpretations best serves the regulatory purpose. Rather, the agency's interpretation must be given "'controlling weight unless it is plainly erroneous or inconsistent with the regulation.'" *Ibid.* (quoting *Bowles v. Seminole Rock & Sand Co.*, 325 U.S. 410, 414, 65 S.Ct. 1215, 1217, 89 L.Ed. 1700 (1945)). In other words, we must defer to the Secretary's interpretation unless an "alternative reading is compelled by the regulation's plain language or by other indications of the Secretary's intent at the time of regulation's promulgation." *Gardebring v. Jenkins*, 485 U.S. 415, 430, 108 S.Ct. 1306, 1314, 99 L.Ed.2d 515 (1988). This broad deference is all the more warranted when, as here, the regulation concerns " a complex and highly technical regulatory program," in which the identification and classification of relevant "criteria necessarily require significant expertise and entail the exercise of judgment grounded in policy concerns." *Pauley v. BethEnergy Mines, Inc.*, 501 U.S. 680, 697, 111 S.Ct. 2524, 2534, 115 L.Ed.2d 604 (1991).

7. This Court does not have any difficulty agreeing with IDEM's contention that the openings in the warehouses are "functionally equivalent openings". The first rule is that when a statute or regulation is clear and unambiguous on its face, the court does not need to "apply any rules of construction other than to require that words and phrases be taken in their plain, ordinary and usual sense." *St. Vincent Hosp. & Health Care Ctr., Inc. v. Steele*, 766 N.E.2d 699, 703-704 (Ind. 2002). The regulation states that fugitive emissions are those that cannot "reasonably pass through a stack, chimney, vent, or other functionally equivalent opening." The warehouse openings are clearly not stacks or chimneys, but they are functionally equivalent to vents. Merriam-Webster Dictionary defines "vent" as "an opening for the escape of a gas or liquid or for the relief of

pressure." *Merriam-Webster On-line Dictionary*, www.m-w.com/cgi-bin/dictionary. Giving the words of the regulation their plain and ordinary meaning, these openings are the functional equivalent of vents. However, the analysis does end at this point. The word "reasonably" must be construed.

8. IDEM urges this Court to construe the word "reasonably" broadly and argues that the mere fact that the emissions pass through the opening is enough to determine that the emissions are not fugitive. However, if this were true, then the word "reasonably" has no meaning. Statutes and rules must be read as a whole. "We 'presume that the legislature did not enact a useless provision'." State v. Evans, 790 N.E.2d 558, 560 (Ind. App., 2003) (citing Moons v. Keith, 758 N.E.2d 960, 965 (Ind. Ct. App. 2001)).

9. This Court concludes that whether the emissions can be reasonably *collected* is essential to the determination of whether the emissions are fugitive. This Court finds and concludes that the IDEM's interpretation is inconsistent with the regulation and with U.S. EPA's national policy for the following reasons.

10. The preamble to the U.S. EPA's original 1980 promulgation of the definition for "fugitive emissions" states:

> EPA has considered comments with respect to the proposed definition of "fugitive emissions," and has determined that one change is appropriate. Instead of defining fugitive emissions as "those emissions which *do not* pass through a stack, chimney, vent, or other functionally equivalent opening," EPA believes that the term should apply to "those emissions which *could not reasonably pass* through a stack, chimney, vent, or other functionally equivalent opening." This change will ensure that sources will not discharge as fugitive emissions those emissions which would ordinarily be collected and discharged through stacks or other functionally equivalent openings, and will eliminate disincentives for the construction of ductwork and stacks for the collection of emissions. Emissions which could reasonably pass through a stack, chimney, vent, or other functionally equivalent opening will be treated the same as all other point emissions for threshold calculation purposes.

45 Fed.Reg. 52692-93 (Aug. 7, 1980). This reinforces the idea that the collection of emissions is an important variable in the definition of "fugitive emissions".

11. The Memorandum, dated February 10, 1999, from Thomas C. Curran to Judith Katz (the "Curran Memo"), submitted as Attachment B to IDEM's Motion for Summary Judgment and as Exhibit G to the Petitioner's Motion for Summary Judgment sets out the factors to be considered in determining whether emissions are fugitive. The Curran Memo indicates that the U.S. EPA's national policy is that each Region must perform a factual case-by-case analysis to determine whether the emissions are fugitive. Implicit in this analysis is an inquiry into whether the emissions can be *reasonably collected.*

12. The Curran Memo states what factors should be analyzed to determine if emissions can be "reasonably collected". At a facility where emissions are not actually collected, this inquiry should include an analysis of (1) the reasonableness of collection, including, but not limited to, cost considerations; (2) whether similar facilities "are subject to national standards and State implementation plan (SIP) requirements (e.g., reasonably achievable control technology, best available control technology, or lowest achievable emission rate) requiring collection, and (3) whether similar sources actually collect emissions.

13. The regulation specifically states that emissions that can "reasonably pass through a stack, chimney, vent, or other functionally equivalent opening" are not fugitive. This Court agrees with the District Court's statement in *United States v. Nucor Corp.*, 17 F.Supp.2d 1249 (M.D. Ala. 1998), "The court cannot imagine any emission in a gaseous state which could not pass through such an opening." If one examines the documents submitted and cited by the parties, it is clear that the U.S. EPA contemplates that whether the emissions can be reasonably *collected* is the main consideration in the analysis. The Court finds the Court's statement in *Nucor*, "If all the plaintiff had to prove is that gasses in a gaseous state can pass through a hole, the plaintiff should perhaps prevail." to be particularly applicable here.

14. While not binding, this Court finds that the United States District Court's opinion in *Nucor* to be very persuasive. The District Court states, "The court initially notes that it cannot accept plaintiff's explicit and implicit argument that all emissions which can pass through a stack, vent, etc. are, ergo, non-fugitive emissions. The court cannot imagine any emission in a gaseous state which could not pass through such an opening. The regulation must contemplate some means of collection, direction and discharge, just as the preamble to the EPA regulation provides." At 1250.

15. The District Court also states "The issue was whether the emissions were fugitive. This required that the plaintiff prove that there was a reasonable system to collect and discharge, not just whether or not gasses can physically pass through a hole." *Id.* At 1250. In accordance with U.S. EPA's interpretation as stated in the Curran Memo and with the *Nucor* case, whether the emissions can be reasonably collected is the question that must be answered.

16. The only question now remaining is a factual one, that is, whether the emissions from this Facility can be reasonably collected as they pass through the openings in the warehouses. The Curran Memo provides the analysis that IDEM or Region V should have performed in determining that these emissions were non-fugitive.

17. This Court must apply a *de novo* standard of review to this proceeding when determining the facts at issue. *Indiana Dept. of Natural Resources v. United Refuse Co., Inc.*, 615 N.E.2d 100 (Ind. 1993). Findings of fact must be based exclusively on the evidence presented to the ELJ, and deference to the agency's initial factual determination is not allowed. *Id.;* I.C. 4-21.5-3-27(d). "*De novo* review" means that:

all are to be determined anew, based solely upon the evidence adduced at that
hearing and independent of any previous findings.

Grisell v. Consol. City of Indianapolis, 425 N.E.2d 247 (Ind.Ct.App. 1981).

18. The OEA may enter summary judgment for a party if it finds that "the pleadings,
depositions, answers to interrogatories, and admissions on file, together with the
affidavits and testimony, if any, show that a genuine issue as to any material fact does not
exist and that the moving party is entitled to judgment as a matter of law." IC 4-21.5-3-
23. The moving party bears the burden of establishing that summary judgment is
appropriate. All facts and inferences must be construed in favor of the non-movant.
Gibson v. Evansville Vanderburgh Building Commission, et al., 725 N.E.2d 949
(Ind.Ct.App. 2000).

19. The IDEM argues that the openings in the warehouses are functionally equivalent
openings and the fact that the emissions pass through these openings means that these
emissions are fugitive. This argument is based on the United States Environmental
Protection Agency (U.S. EPA), Region V's letter dated April 16, 1996 to Paul
Dubenetzky from Cheryl Newton (the "Region V Letter").

20. It is not clear from the Region V Letter what analysis Region V undertook to determine
whether these emissions were fugitive. The letter states "Region V has carefully
reviewed the facts of this case and relevant regulation and guidance and confirms that our
position on this issue is correct." Neither IDEM nor Region V has presented the
supporting evidence for this conclusion. Attempts to obtain the supporting
documentation by the Petitioner's attorney were unsuccessful. Exhibit H, Seagram's
Response to IDEM's Motion for Summary Judgment and Seagram's Cross-Motion for
Summary Judgment.

21. The Petitioner has presented extensive evidence regarding the whiskey aging process and
the effect the collection of ethanol emissions would have on this process. The Petitioner
has shown by a preponderance of the evidence that the collection of the ethanol emissions
would negatively affect product quality. The Petitioner has also presented sufficient
evidence to prove that such emissions are not collected at other similar facilities and that
U.S. EPA has not identified any reasonably available control technology (RACT) for
ethanol emissions from alcohol beverage aging warehouses.

22. Based on the evidentiary matter before it, this Court concludes that there is no genuine
issue to any material fact. The Petitioner has met its burden of proof by a preponderance
of the evidence in this matter. The emissions from the Facility are fugitive emissions,
therefore the Facility is not a major source under 40 CFR § 70.2 or 326 IAC 2-7-1(22)
and it is not required to obtain a permit under 40 CFR Part 70 or 326 IAC 2-7.

ORDER

AND THE COURT, being duly advised, hereby ORDERS, JUDGES AND DECREES that the Petitioner's Cross Motion for Summary Judgment is GRANTED and IDEM's Motion for Summary Judgment is DENIED. The Commissioner is ordered to rescind the Part 70 Operating Permit No. T-137-6928-00011 for the facility located on Highway 350 West, Milan, Indiana.

You are further notified that pursuant to provisions of IC 4-21.5-7-5, the Office of Environmental Adjudication serves as the ultimate authority in administrative review of decisions of the Commissioner of the Indiana Department of Environmental Management. This is an order subject to further review consistent with applicable provisions of IC 4-21.5 and other applicable rules and statutes.

IT IS SO ORDERED THIS __4th__ day of __August__, 2004.

Catherine Gibbs
Environmental Law Judge

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SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT

FINAL DRAFT STAFF REPORT FOR

New Draft Rule 4695 (Brandy Aging and Wine Aging Operations)

September 17, 2009

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I.   SUMMARY

A.   Reasons for Rule Development and Implementation

The California Air Resources Board (ARB) and United States Environmental Protection Agency (EPA) classified the San Joaquin Valley Air Basin (SJVAB) as a severe and serious non-attainment area for the state and federal ozone standards, respectively. In accordance with Federal Clean Air Act (CAA) requirements for non-attainment areas, the San Joaquin Valley Unified Air Pollution Control District (District) adopted the 2007 Ozone Plan to establish the strategy for attaining the federal eight-hour ozone standard. That plan is comprised of regulatory and incentive-based measures to reduce emissions of nitrogen oxides (NOx) and volatile organic compounds (VOC), which are the precursors to ground-level ozone.

The 2007 Ozone Plan contains a commitment to develop a control measure for VOC emissions from brandy aging and wine aging operations. Emission controls have already been installed on most of the large brandy aging operations as an emission reduction measure to comply with the requirements of Rule 4694 (Wine Fermentation and Storage Tanks), to which these emission reductions are credited. In addition to controlling VOC emissions from brandy aging operations, this control measure would require Reasonably Available Control Technology (RACT) controls on wine aging operations at Major Sources.

As stated in the 2007 Ozone Plan possible cost effective emission reductions could be achieved for brandy aging through adding emission control technologies. Such

additional technologies are considered to be beyond RACT but are not yet achieved in practice for these operations. After a more extended operational period and a determination that there would be no adverse impact on either the aging operation or the quality or consistency of the product, the District may revisit this for Best Available Control Technology (BACT) for new or modified sources. The identified control technologies are considered to be applicable to the aging of wine as well as to brandy since the basic process of aging in wooden tanks or barrels in a warehouse is very similar. Major differences exist in the level of emissions, between the two operations and the impact of this difference on technology transfer as examined by this project.

The proposed rule will fulfill the District's 2007 Ozone Plan commitment for control measure S-IND-14 (Aging of Brandy and Wine) in an effective, practicable, technologically feasible, and economically reasonable method, as determined by the District's Governing Board. This rule will also satisfy SIP commitments with the requirement of emission controls which help produce Reasonable Further Progress (RFP) for the Attainment Demonstration; will reduce emissions that are quantifiable, surplus, real, and enforceable; and will satisfy the federal requirement to design a plan to achieve ozone attainment.

B.   Climate Change

The California Global Warming Solutions Act of 2006 (AB 32) created a comprehensive, multi-year program to reduce greenhouse gas (GHG) emissions in California, with the overall goal of restoring emissions to 1990 levels by the year 2020. In the coming years, ARB and the Legislature will be developing policies and programs to implement AB32.

The District believes that the evidence and the rationale that climate change is occurring is compelling and convincing. In addition to the long-term consequences of climate change, the District is concerned with the potential ramifications of more moderate but imminent changes in weather patterns. The Valley depends heavily on agriculture for its economy. Unanticipated and large fluctuations in these patterns could have a devastating effect on the Valley's economy.

While there are many win-win strategies that can reduce both GHG and criteria/toxic pollutant emissions, when faced with situations that involve tradeoffs between the two, District staff believes that the more immediate public health concerns that may arise from criteria or toxic pollutant emissions should take precedence.

C.   Description of the Project

This proposed new rule would codify the requirement for Best Available Retrofit Control Technology (BARCT) and Reasonably Available Control Technology (RACT) VOC emission controls and management practices which have been employed by wine fermentation operators under Rule 4694's alternative emission reduction option. This

rule would specify RACT for major sources as the means to achieve the maximum amount of VOC emission reductions by using control technologies that are reasonably available. Any VOC emissions reduction from the control of brandy aging have already been accounted for by Rule 4694 and are not considered to be additive for SIP purposes.

This rule applies to all brandy aging and wine aging facilities but exempts those facilities which have a Stationary Source Potential to Emit of less than 10 tons per year since they are not Major Sources. The federal Clean Air Act (CAA) requires all operations at Major Sources to have RACT, so controls for aging operations at those facilities are included in the rule, regardless of the size of the aging operation, as long as it is conducted at a Major Source. Separate thresholds for brandy aging and wine aging operations were determined based on operating characteristics, emissions, and a cost effectiveness analysis.

Existing brandy aging control systems have been installed and operating on four warehouses for almost two years, but, due to the brandy aging process length, this is not sufficient time to judge the impact of the controls on operations and product quality. Therefore, the compliance date has been set to allow for time to reexamine rule requirements if operational or product quality issues are deemed to be seriously detrimental. District staff reviewed rules from other air districts in California, gathered information from the Federal Alcohol and Tobacco Tax and Trade Bureau, the Wine Institute, and from individual stakeholders to serve as guidance and as information sources for rule development. District staff found that, at this time, there are no air districts in the nation that have regulations to control VOC emissions from brandy aging and wine aging operations.

The District staff understands that the nature of whiskey aging operations differs from wine and brandy aging. Specifically, the ambient conditions, such as storage temperature and humidity, as well as seasonal variations, are important factors in the whiskey aging process.   All aging processes, depends upon the interaction of product in oak barrels, whiskey aging operations strive for a particular blend of temperature, humidity, and ventilation, leading to different types of warehouse. (Source: EPA, *Final Report: Emission Factor Documentation for AP-42, Section 9.12.3, Distilled Spirits, p. 2-7* (March 1997).) Therefore, whiskey aging is not considered or included in this rule development process.

D.   Rule Development Process

As part of the rule development process, District staff conducted a series of public work shops on February 4, April 9, and June 17, 2009. At these meetings, District staff presented the objectives of the proposed rulemaking project and solicited comments and suggestions, which were then used to develop the rule and amend/augment the staff report.

Pursuant to state law, District staff is required to perform a socioeconomic impact analysis prior to the adoption, amendment, or repeal of a rule that has significant air quality benefits or that will strengthen emission limitations. As part of the District's socioeconomic analysis process, District staff sought representatives from interested groups to participate as members of a Socioeconomic Focus Group. The Focus Group assisted District staff in determining the appropriate method for gathering information on regulatory compliance costs and business impacts resulting from compliance with the rule. The results of the socioeconomic analysis were compiled into a report that was presented along with the refined version of the proposed rule to the public and interested parties during the final workshop on June 17, 2009. The date for the public hearing to consider adoption of the proposed rule amendments is September 17, 2009.

II.   DISCUSSION

A.   CURRENT REGULATIONS

There are no existing rules in the nation that require controlling VOC emissions from brandy aging and wine aging operations. Rule 4623 (Storage of Organic Liquids) limits VOC emissions from the storage of organic liquids. Although not identified as a rule deficiency, EPA expressed concern that the rule provides an exemption for tanks used in wine fermentation and storage of resulting products, by-products, and spirits. EPA considers VOC emissions from this source category to be significant and recommended further study and analysis.

District Rule 4694 (Wine Fermentation and Storage Tanks) requires installation and operation of VOC emission control system to reduce emissions from wine fermentation and storage operations. As an alternative to controlling the emissions from wine fermentation and storage tanks, Rule 4694 allows operators to mitigate fermentation emissions by controlling alternative emission sources, such as reductions in surplus emissions from mobile sources, area sources, or other stationary sources. In lieu of installing VOC control devices on wine fermentation tanks to fulfill the Rule 4694 requirements, operators voluntarily offered to control surplus emissions from brandy aging operations to obtain equivalent reductions which could then be creditable as Certified Emissions Reduction Credits (CER) under Rule 4694.

To obtain the CER, operators of brandy aging facilities modified existing brandy aging warehouses to meet the requirements for a Permanent Total Enclosure as specified in EPA Test Method 204. This enabled ethanol emissions to be captured and destroyed using regenerative thermal oxidizer technology. Until the successful demonstration that the operation of the capture and control system will not result in unacceptable impacts on brandy quality, consistency, or volume loss, the conditions of the operating permits are provisional and subject to revisions. Operation of these controls has demonstrated that they are technologically feasible as VOC controls and are tentatively considered applicable to both wine aging and brandy aging, pending final determination of the controls impacts on the brandy aging operations.

B.   SUMMARY OF PROPOSED RULE

Proposed new Rule 4695 would implement a VOC control measure (S-IND-14) in the Ozone Plan. The draft rule would serve as a "backstop" measure to codify the control of VOC emissions from the aging of brandy which are currently being implemented by operators as an alternative compliance option in lieu of controlling the emissions from wine fermentation and storage in order to comply with Rule 4694 (Wine Fermentation and Storage). This proposed new Rule will require appropriate VOC control measures for wine aging operations which are currently uncontrolled. The rule applies to wine aging and brandy aging operations at Major Sources, which have a Potential To Emit of at least 10 tons VOC per year. If the facility is a Major Source, the rule requirements apply to that facility's brandy and wine aging operations, regardless of aging operation's size, container size, or container material type. The rule requires the brandy aging and wine aging operations to be assessed separately with independent thresholds and application of control technologies.

The major rule requirements include RACT, Additional RACT, and BARCT based on the throughput or emissions from the brandy aging or wine aging operations:

- For a facility with a brandy or wine aging operation which has either an inventory or emissions less than Table 1 thresholds, operators must implement Reasonable Available Control Technologies (RACT) to include record keeping and work emission minimization practices. Such work practices include: prevent, minimize, and restrict the unnecessary occurrence of brandy or wine exposure to the atmosphere; prevent, minimize, and restrict the occurrence of leaks and spills; implement immediate clean up of leaks and spills by rinsing leaks or spills with water and washing the rinse into a proper drain; and implement immediate corrective actions to prevent a reoccurrence of a similar leak or spill. These are all reasonable practices currently being used by existing operations.

- For a facility with a brandy aging operation that equal or exceed both the applicable inventory and the emissions thresholds listed in Table 1, the operator shall implement brandy RACT by implementing record keeping and work emission minimization practices in addition to BARCT emission capture and control by use of a Permanent Total Enclosure (PTE) that is vented to a control device.
  - This emission control implementation is more stringent and has a total control efficiency of 90 percent through the use of the Permanent Total Enclosure (EPA Method 204) to encapsulate the emissions in the building (92% control efficiency) which are then vented to a Thermal Oxidizer (TO) that burns off the VOC emissions (98% control efficiency).
  - BARCT does not require refrigeration, but large warehouses usually practice refrigeration to minimize ethanol evaporative loss.
  - The rule requires warehouses to continuously meet the criteria for Normal Operation except for periods when the non-Personnel access doors are

opened for personnel and equipment access as required for operational or maintenance functions and/or when the VOC control device is shutdown for scheduled routine maintenance. Cumulative duration for all such periods are not exceed eight (8) percent of the total operating hours or 701 hours per year, whichever is less. This duration includes periods of downtime as required to perform scheduled routine maintenance, which are not to exceed three (3) percent of the total hours of operations or 240 hours per year, whichever is less.

o The rule also provides for an alternative control measure which may be approved by the APCO, provided it is demonstrated that brandy emissions will not exceed 0.3 proof gallons per 50 gallons. This would be equivalent to a warehouse with a system capable of a 90% combined capture and control efficiency.

- For a facility with a wine aging operation which equals or exceed both the applicable inventory and the emissions thresholds listed in Table 1, the operator shall implement RACT record keeping and work emission minimization practices in addition to Additional RACT. Additional RACT is RACT for larger sources based on the observed emission reduction techniques commonly used by such operations. Additional RACT is not applied to smaller operations and is not as stringent as BARCT for this class and category of source. Additional RACT specifies maintaining a nominal warehouse daily temperature, averaged over a calendar year, not to exceed 70 degrees Fahrenheit.

  o As explained later in this report, research into the affects of humidity and temperature has shown that controlling these factors can reduce evaporation and therefore control VOC emissions. The 70 degree temperature threshold was set high enough to allow for variations in aging practices and equipment limitations while still being low enough to produce meaningful reductions.

  o The applicability threshold of 590,000 gallons is based on a 10,000 barrel inventory of 59 gallons per barrel. Such an operation would have an Uncontrolled Aging Emission (UAE) of 16,000 pounds per year and was selected as a natural breakpoint between the large wine aging operations that implement refrigeration or temperature control and the small wine aging operations that do not implement refrigeration.

  o Two additional RACT control alternatives to the temperature option are provided in the rule. The first alternative would allow a control that reduces the VOC Uncontrolled Annual Emissions by 50%. This factor will be calculated by using the UAE calculation equation and an Aging Emission Factor (AEF) of 0.02783, which is based on the District default 3% evaporative loss rate, as explained below. This option is considered to produce equivalent reductions to the temperature option.

  o The second control alternative is to age wine in non-porous tanks. These tanks must be equipped with operable pressure-vacuum relief valves and the temperature of the aging wine must be maintained at or below 75

degrees Fahrenheit. This alternative is already achieved in practice on tanks which are used for wine storage and must comply with Rule 4694 (Wine Fermentation and Storage) requirements.

Table 1 below summarizes the thresholds and applicable requirements for the various sizes of operations, as discussed above.

Table 1.				
Product Type	Total Annual Aging Inventory (gallons per year)	Uncontrolled Aging Emissions (lbs/yr)	Requirement	Control Technology Level
Brandy	< 40,000	< 8,000	Records & Work Practices	RACT
	≥ 40,000	≥ 8,000	Records & Work Practices & PTE vented to a control device	RACT and BARCT
Wine	< 590,000	<16,000	Records & Work Practices	RACT
	≥ 590,000	≥ 16,000	Records & Work Practices & Temperature control	RACT and Additional RACT

The difference between brandy aging and wine thresholds are due to the District calculating emission factors based on an average annual brandy evaporative loss rate of 3 proof gallons per barrel per year, and an average annual wine evaporative loss rate of 3% by volume per barrel per year, and a cost effectiveness of approximately $25,000 per ton for both. Using these emission factors, wine has an ethanol level of nearly one-sixth that of brandy and a proportionally lower emission rate. Because of the differences in emission rates, wine aging controls have much higher cost effectiveness values compared to a similarly-sized brandy aging warehouse. Cost effectiveness details are provided in Appendix C.

The rule allows facilities the opportunity to calculate and use their own Uncontrolled Aging Emissions (UAE) in relation to this rule's thresholds. To determine a specific operation's Uncontrolled Aging Emissions (UAE) use the following formula:

$$UAE = TAAI * AEF$$

Where:

UAE =   Uncontrolled Aging Emissions, in pounds of ethanol per year.

TAAI =   Total Annual Aging Inventory, in gallons per year.
AEF =   Aging Emission Factor, in pounds of ethanol per gallon.

Total Annual Aging Inventory is an average of a calendar year inventory derived from the Tobacco Tax and Trade Bureau (TTB) Form 5110.11 for brandy and Form 5120.17 (replaced Form 702) for wine. The calculation is as follows:

$$\text{TAAI} = \sum \text{GMI} \div 12 \text{ months/year.}$$

TAAI = Total Annual Aging Inventory, in gallons per year.
GMI = Gallons in Monthly Inventory, in gallons per year.

The District's default Aging Emission Factors (AEF) are: brandy 0.1986 lb ethanol per 50 gallon barrel and wine 0.02783 lb ethanol loss per gallon wine. These values are based on the District default values of evaporative loss of 3 proof gallons per barrel per year. This loss rate is based on the average loss rate for all permitted facilities in the District, except one facility that is not industry representative. The wine default value is based on an evaporative loss rate of 3% by volume per barrel per year. This is explained in great detail below. Using the above loss rates allows for the aging emission factors to be calculated as follows:

Brandy Default AEF = 3 proof gallons loss/50 gallon barrel x 0.5 gallon ethanol/ proof gallon x 6.616 lb ethanol/gallon.
                    = 0.1986 pounds of ethanol/gallon of brandy aged

Wine Default AEF   = 0.03 gallons loss/gallon wine x 8.14 lb wine/gallon wine x 0.114 lb ethanol/lb wine (simplified from Santa Barbara Air Pollution Control District's 'Wine Production Emission Factors).
                    = 0.02783 pounds of ethanol/gallon of wine aged

Operators have indicated that their site-specific loss rate may be significantly lower than the assumed 3% rate. The rule allows operators to calculate the AEF using such a site-specific loss rate in place of the District's default values.   This allowance is to reflect the effects of individual practices that may be employed to reduce evaporative losses.

Additionally, the rule provides for two alternative emission controls for tanks that are not housed in a PTE and vented to a VOC control device. First, the rule allows use of such tanks if the operator can demonstrate that the aging emissions do not exceed 0.3% by volume. This fugitive emission value is equivalent the fugitive emissions released by a PTE and RTO that have a combined destruction efficiency of 90%. The basis for this allowance is as follows:

- Wine barrels have a District default evaporative loss rate of 3%.
- The PTE captures 92% of this 3% evaporative loss.

- The PTE is vented to a VOC control device that destroys 98% of the emissions captured by the PTE.
- Total capture and control of the system is
    0.92 x 0.98 = 0.90 capture and control destruction efficiency
- If 90% of the evaporative loss is captured and destroyed, then 10% of the ethanol (or 0.3% of the total wine) would be emitted to the atmosphere.
    0.03 x (1 - 0.90) = 0.003 or 0.3% of the total wine
- Therefore, a system with VOC emissions of less than 0.3% of the total wine is equivalent to a PTE and VOC control having a 90% capture and control efficiency.

Secondly, the rule allows operators to use non-wooden tanks if they are equipped with pressure vacuum relief (PVR) valves and temperature controls. The combination of the PVR valves and temperature control reduces or eliminates evaporation and emissions from the aging operations by maintaining the tank contents in a static state. The PVR valves stay closed during aging since refrigerating the tank contents prevents them from evaporating and expanding and contracting due to temperature variability. Tank contents are maintained at or below 75°F. Volumetric loss rates for these tank controls are expected to be 0.3% or less, which would be equivalent to the other two control options.

District research has found that temperature can be used as a primary, singular, and direct wine ethanol emission reduction/control technique. Based on an initial study's data (Blazer, R. M., Wine Evaporation from Barrels, Practical Winery and Vineyard Jan/Feb 20-22 (1991)), District staff ran a linear regression that showed a proportional relationship between temperature and ethanol loss from wine aging in barrels. Further research concluded that ethanol loss is independent of humidity. The Blazer data may have limited use but it is an appropriate example that aptly demonstrates for the purposes of this rule the scientific relationship of decrease temperature and proportional decrease of ethanol evaporation from barrel aging wine as shown below in Diagram 1.

Diagram 1. Linear regression of temperature and ethanol loss per barrel.

Temperature and Ethanol Loss per Barrel

$y = 4.353x - 209.58$
$R^2 = 0.9759$

Ethanol Loss (mL) vs Temperature (°F)
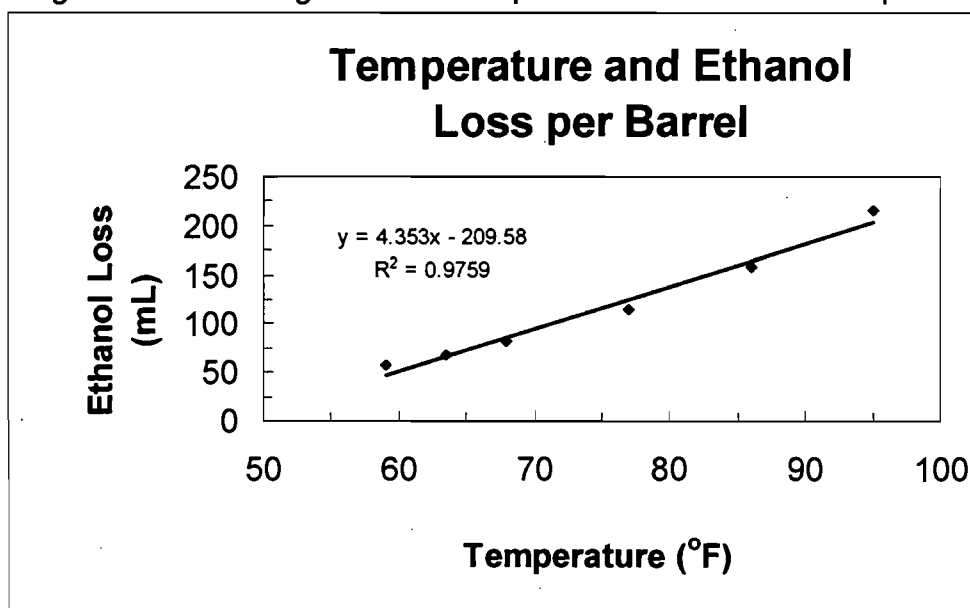
Because there are no other wine aging emission controls regularly put into practice other than temperature control, as currently achieved in practice for larger brandy aging and wine aging operations, and because temperature control is not only used to substantially reduce evaporative loss but to increase product quality; temperature control is to be considered a Reasonably Available Control Technology (RACT) practice. Because this practice will not generate additional reductions from current practices, no further emission reductions for RACT will be credited to this rule.

The use of a controlled nominal daily temperature, averaged over a calendar year, is considered RACT for two reasons. First, the San Joaquin Valley has great diurnal and seasonal temperature variations. Diurnal variations from night to day average 30 degrees, with extreme diurnal variations of up to 64 degrees Fahrenheit. The seasonal winter to summer monthly variations average 60 degrees, with extreme variations of up to 98 degrees Fahrenheit, based on a summer high of 115 degrees to winter low of 18 degrees. Second, the existing larger brandy aging and wine aging operations already employ refrigeration to maintain summer temperatures below a certain point, generally around 60 degrees Fahrenheit. The exact aging temperature can vary by 10 degrees Fahrenheit at certain times of the year, depending on the outside temperature, related operations occurring in the warehouse, and the refrigeration equipment limitations.

Another seasonal operational factor involved in an aging warehouse's daily temperature fluctuations is fermentation. Fermentations produce large amounts of carbon dioxide gas. During the fall months of wine fermentation, doors nearest a fermentation section of the aging warehouse may be opened to exit the excess carbon dioxide gas thus contributing to daily variations in a controlled warehouse's daily temperature. Consequently, because of the above detailed diurnal and seasonal temperature

fluctuations the warehouse nominal daily temperature must be averaged over the course of a calendar year.

All wine aging and brandy aging operations at Major Sources must implement RACT as detailed earlier. Larger brandy operations must also implement capture and control of VOC emissions by using a PTE vented to a control device. This system is much more costly than the RACT requirements and is therefore considered a BARCT. As detailed in Appendix C, the high cost effectiveness of this BARCT requirement limits its application to the largest brandy aging operations which would otherwise have the highest emissions of VOC.

Currently, four of five largest brandy aging operations in the District are using a warehouse that is a PTE venting to a Regenerative Thermal Oxidizer (RTO). Out of several control devices at stakeholder disposal, the brandy aging industry has universally selected the use of a Regenerative Thermal Oxidizer (RTO) due to its low annual maintenance costs for this control application. Because of the current installation and operation of the RTOs, it has been demonstrated that RTOs are practical and effective controls for high levels of VOC emissions. The RTOs that are currently in operation were installed as an alternative compliance option in lieu of controlling the emissions from wine fermentation and storage for Rule 4694 (Wine Fermentation and Storage).

As explained in Appendix B, the expected reductions are summarized in Table 2 below. These emission reductions only include the reductions which will be realized from the one, uncontrolled brandy aging warehouse and do not include those reductions that are creditable to the Rule 4694.   The compliance date for achieving this reduction is January 1, 2012.

Table 2: Emission Reductions for Rule 4695		
Operation	Tons per Year	Tons per Day
Brandy Aging	42.6	0.12
Wine Aging	0[1]	0
Total	42.6	0.12

[1] Current wine aging facilities meet RACT control requirements.

In determining a reasonable level at which to require BARCT, staff used a $25,000 per ton cost effectiveness cut point. This level is similar to that which has been historically used in other VOC control rule determinations. This value will not generally cause a significant socioeconomic impact and yet will still affect a reasonable level of emission control.

The brandy evaporative loss rate of 3 proof gallons per barrel per year is based on the average loss rate for all permitted facilities in the District (except one facility that is not

industry representative). The subsequently calculated brandy aging emission factor is 0.1986 pounds ethanol per gallon annually.

District research developed an evaporative loss rate scale showing that the annual wine aging evaporative loss rate for various operations in the District may range from 0.16% to 10% by volume. It was found that within that range, the 3% value is the appropriate value to use for the District's evaporative loss rate, which takes into account weighted inventories and evaporative loss rates. The wine evaporative loss rate of 3% by volume per barrel per year and the wine aging emission factor of 0.02783 pounds ethanol per gallon are based on the results of District research outlined in the following:

- According to Tobacco and Tax Trade Bureau (TTB) data for the years 2004, 2005, and 2006; and Wine Institute wine production values for those same years, wine loss during production is only 0.16%. This includes losses due to spillage, leakage, soakage, evaporation, include aging, and other losses normally occurring from racking and filtering. However, the overwhelming majority of this wine production is not aged. Therefore, for those wines that go through this production process and are then aged, the loss rates can be no less than 0.16% by volume per year. This sets the low end of the evaporative loss scale to 0.16%.

- District research has also shown that non-climate controlled wine aging warehouses in hot climates may lose up to 10% by volume, thereby setting the high end of the evaporative loss rate scale at 10%. From District surveys there are 22 wine aging facilities in District operation. Of those facilities, 21 facilities are less then one-tenth the size of the largest facility. These smaller facilities average approximately 800 – 1,000 barrels in aging inventory. District staff understands that these smaller facilities do not utilize climate controls for their aging barrels and that these barrels are aged in existing operational buildings (fermentation, storage tank, filtering, and/or bottling rooms/buildings). From the District survey these smaller facilities make up 37% of the annual wine aging inventory gallons.

- District research has also shown wine aging warehouses that are in mild climates (or warehouses that are operated with climate controls of approximately 60 degrees Fahrenheit and 75 percent humidity, according to stakeholder information) are expected to have loss rates of no greater than 3% by volume, based on the factor developed by the publicly-vetted Santa Barbara Air Pollution Control District permit development process. Santa Barbara has a mild climate with average temperature of 61 degrees Fahrenheit and 50% humidity.

- The likelihood that losses of no greater than 3% is also supported by data from the TTB whereby losses due to spillage, leakage, soakage, evaporation, including wine aging, and other losses normally occurring from racking and filtering, of up to 3% loss by volume, are not taxed. It is assumed that this allowance is recognition that the 3% loss is what would normally occur from a reasonably well-managed wine production operation. Since the other 97% is

taxed, operators would have an incentive to minimize emissions or they would end up being taxed on lost product.

- Published research has also shown that measured wine evaporative loss rates which were measured under environmentally controlled conditions in wine aging warehouses and caves - demonstrate a wine aging evaporative loss range from 0.3% to 1.4% by volume. This measured wine evaporative loss rate range was based on the spread of relative humidity from 60 to 75% and temperature 59 to 95 degrees Fahrenheit. This relative humidity and temperature spread was selected from the data set to reproduce the wine evaporative loss rates submitted by stakeholders of 0.29% to 1.4%.

The rule includes an allowance for operators to use site-specific loss rates in determining the applicability of the rule requirements to their aging operations. Stakeholders have requested that the site-specific loss factors also be used in calculating the emissions inventory for this source category. While the District is always open to improving the accuracy of the emissions inventory, such a determination is beyond scope of his project and will be pursued as a separate issue.

District Staff welcomed input from stakeholders who submitted similar but a facility specific wine evaporative loss rate (1.4%), cost of control total capital and annual investment data, and a resulting cost effectiveness analysis. Staff Report Appendices B, C, and D incorporated stakeholder results. These analyses resulted in a second wine cost effectiveness value of $76,695 per ton. The District subsequently adjusted up the above wine aging threshold limit to 30 tons (60,000 pounds) per year with a subsequent cost effectiveness of value of $26,700 per ton. Because there are no wine aging warehouses of that size in the Valley, and because the District's permitting process would prevent the establishment of one that large, the scenario of a wine aging operation large enough that would require the installation of a BARCT PTE and VOC control was dropped from the rule.

III.   BACKGROUND

A.   Brandy and Brandy Aging

The name brandy comes from the Dutch word *brandewijn,* meaning "burnt wine." The name is apt as most brandies are made by applying heat, originally from open flames, to wine. This wine is boiled at a temperature between the boiling point of alcohol (ethyl alcohol) and the boiling point of water. This heating a liquid to separate components with different boiling points is called heat distillation. The low-boiling point liquids distilled from wine include almost all of the alcohol, a small amount of water, and many of the wine's organic compounds. It is these chemicals that give brandy its taste and aroma. The resulting vapors are collected and cooled. To drive out more of the water, always saving the alcohol, the distillation process can be repeated several times more depending on the alcohol content desired.

In California, these brandies are generally made of wine produced from many varieties of grapes but principally use Thompson Seedless and Chardonnay. Brandy is produced with an ethyl alcohol of less than 190° proof and bottled at a minimum of 80° proof. In the United States, "proof" denotes the ethyl alcohol content of a liquid at 15.6°C (60°F), stated in units of twice the percent ethyl alcohol by volume. For governmental reporting purposes, ethanol is reported in volume units of proof gallons, which is one liquid gallon of proof spirits which are 50% ethanol, by volume, at 60 degrees Fahrenheit.

B.   Wine and Wine Aging

Wine is an alcoholic beverage produced by the fermentation of sugars in fruit juices, primarily grape juice. This fermentation process is an anaerobic breakdown of organic compounds by microscopic yeast organisms which provide complicated enzymes that, in the presence of sugar, form alcohol, carbon dioxide, glycerin, and other products.

The amount of time required to complete a fermentation is a function of temperature, where at 55 to 60^{0}F, wines are fermented in 7 to 10 days, and at 75 to 80^{0}F, wines will take 3 to 6 days to ferment. In commercial wineries fermentation of the grape juice or must (grape juice plus berry skins) commonly occurs in fixed-roof steel fermentation tanks inoculated with yeast. After fermentation, wine is transferred a number of times between storage tanks to perform various finishing operations such as racking or decantation for separation of sediment, and filtration.

In California, table wines can be made from either a single grape variety or made from a combination of many grape varieties. These table wines have an alcohol content that ranges from 7 to 14 percent by volume (14° to 28° proof). Some of these table wines are subsequently aged in oak barrels or casks, to improve the quality. The changes that occur during the aging process are the result of interactions between the aging wine and the oak barrel, driven by the conditions of the surrounding atmosphere which may have both diurnal and seasonal variation. Both the ethanol and water evaporate from the surface of the barrel during the aging process with the rate of evaporation depending upon both the porosity of the barrel and the atmospheric conditions of the storage room among other factors.

C.   Fugitive Emission Source: The Barrel

Modern barrels (Diagram 2) are made of oak staves (Diagram 3) shaped into bulging cylinders that are bound by steel hoops and capped with flat circular heads at both ends The belly, or bilge, allows them to be rolled and turned, and when stored horizontally, facilitates racking or the transfer of the liquid to another barrel.

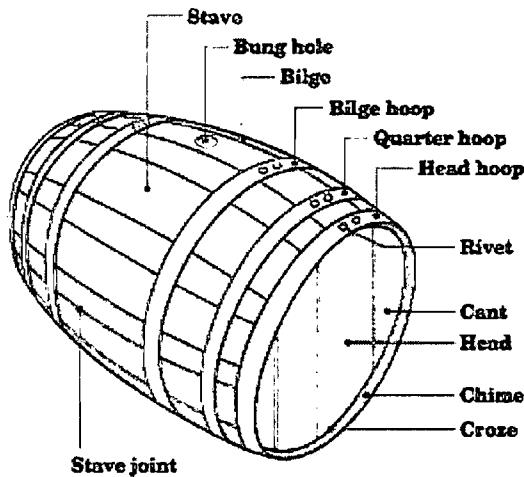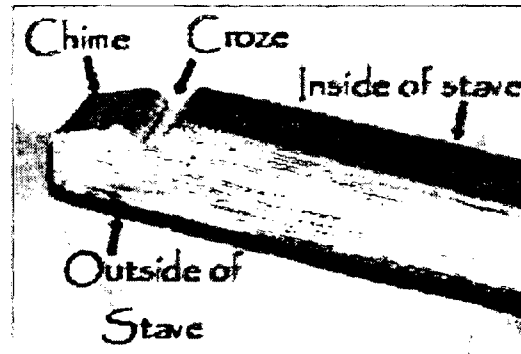Diagram 2. Wood barrel components.   Diagram 3. Stave components.

The inside of the barrel is then subjected to fire, known as 'toasting' that caramelizes some of the woody substances (generally sugars) which develop into a multitude of sweet woody aromas, which will add flavor to whatever liquid is stored inside the barrel. For wines, this 'toast' level can be adjusted according to the customers' requests: light, medium or heavy toast. For Bourbon, the 'toasting' is heavy (or charred) that leaves a heavy charcoal layer on the inside that greatly mellows the liquid contents.

Once finished, a test of impermeability is made by pouring a small amount of hot water under pressure into the barrel. This procedure makes it possible to immediately detect any leaks, or mere traces of moisture caused by unusually porous areas or a manufacturing defect.

California brandy makers buy used American Bourbon barrels to age their brandy. These barrels generally hold 53 gallons are made of American oak. Barrels used for wine are fashioned in two principal configurations: the 59-gallon French Bordeaux and the 60-gallon French Burgundy. The latter is nearly three inches shorter and over one inch broader at the bilge. Wine barrels are purchased new or used and are made of oak from America, France, or Eastern Europe. Larger barrels of 79 to 185 gallons are called puncheons and offer a lower wood surface-to-wine ratio imparting less oak and vanilla characteristics to the wine. Large upright tanks generally fixed in place and constructed of wood are called casks and can be used to ferment or age the wine.

D.   Fugitive Emission Driving Force: Diffusion

Wood is a solid, porous, and permeable material. Porosity is the volume fraction of void space in a solid. The porosity is reported to be 1.2 to 4.6% of dry volume of wood cell

wall. Permeability is a measure of the ease by which fluids are transported through a porous solid under the influence of some driving force, such as chemical potential. There are several types of chemical potential driving forces, but in this instance, it is diffusion. The diffusive movement of moisture and vapor through the wood is by several types of passageways and variations in wood structure. These pathways consist of cavities in vessel cells, fibers, ray cells, pit chambers, intercellular spaces, and transitory cell wall passageways.

Diffusion will redistribute moisture and vapor between the interior and exterior barrel surfaces, until the moisture or vapor level is uniform throughout the wood and the surrounding air, and a zero chemical potential gradient is reached at equilibrium.

Diffusion's constant driving force to reach equilibrium, forces a wine's 7 to 14%, or a brandy's 40% alcohol from the porous barrel into the housing room where, at least for brandy, there is a constant state of disequilibrium. This diffusion of alcohol and water over time causes a decrease in volume of the barrel's liquid contents. This loss is historically known as "the angels share" but is known today as fugitive emissions.

IV.   Fugitive Emission Control Techniques

A.   Emissions Capture System

The brandy storage warehouse functions as an enclosure from which the ethanol emissions can be captured. The capture efficiency is primarily a function of the configuration of this structure. Since such a structure can be sealed and ventilated to a control device such that it qualifies as a Total Enclosure pursuant to U.S. EPA Method 204, the theoretical capture efficiency could be considered to be 100%. However, since brandy aging and wine aging operations are a continuous 24 hour/day operation throughout the year, it would be difficult and expensive to continuously maintain the warehouse in a Total Enclosure status due to the on-going requirements to transport the product into and out of the warehouse and the requirements for maintenance during which the warehouse must be opened or the control device must be shut down. During such periods, uncontrolled emissions are delivered to the atmosphere in the absence of expensive air lock systems and/or redundant control devices.

Although neither of the terms "Fan Inlet Pressure Control Point" and "Maximum Allowable Negative Gauge Pressure" appear in EPA Method 204, the industry has previously indicated that there are technical difficulties with continuous monitoring and directly controlling a differential pressure of 0.013 mm Hg and has requested use of a surrogate for monitoring and for controlling of the induced draft fan. The selected surrogate is the pressure control instrument for the induced draft fan, typically located on the inlet ductwork near the fan inlet plenum. Due to pressure losses in the ductwork, the vacuum at this point is considerably higher than that in the warehouse (on the order of 2 "WC) which is more easily measured and controlled. The facility is required to

establish, control, and periodically demonstrate a control set pressure at this point which ensures that the PTE requirement of 0.013 mm Hg is met.

B. Control Technologies and Devices (Exhaust-type)

1. Thermal Oxidation (Incineration)

Thermal oxidizers (TO) use the process of combustion to destroy VOCs. A basic TO system consists of a combustion chamber, burner, stack, and combustion controls. All hydrocarbons are oxidized to carbon dioxide and water vapor by the proper mix of temperature, residence time and turbulence within the reactor chamber. Combustion of the contaminated gas stream occurs at high temperatures, normally 650°C to 870°C (1,200°F to 1,600°F) when treating low concentration streams. Recent source tests at existing facilities utilizing TO control have demonstrated a 98% destruction efficiency at a combustor temperature of 1400° Fahrenheit.

TO systems can be divided into recuperative or regenerative systems, based on methods used to increase operating efficiencies by capturing heat from the combustion process. Recuperative TO systems increase fuel efficiency by use of a gas pre-heating section and a heat recovery section. Heat recovery can be as high as 70%. A regenerative system provides extremely high thermal-energy recovery; up to 95% of heat energy can be recovered. Regenerative TO systems use a ceramic heat-exchange bed to preheat process air to within 5% of the oxidation temperature.

VOC conversion efficiencies range from 95% to 99.9% for TO systems. However, the combustion of supplemental fuel for the oxidation produces NOx, an ozone precursor like VOC, thus offsetting some of the VOC emission reduction. The District considers thermal oxidation as technologically feasible for the application to brandy aging and wine aging.

Stakeholders have implemented thermal oxidation controls for their brandy storage warehouses and are currently adjusting the functional operations of this system to minimize any detrimental quality and evaporative effects. This control technology is currently operating on six permit units in the San Joaquin Valley.

2. Catalytic Thermal Oxidation

A catalytic thermal oxidizer (CTO) is essentially a thermal oxidation unit with a catalyst module. These units are similar in design to recuperative units, except that VOCs are oxidized at lower temperatures using precious metal or metal-oxide-based catalysts. Operating at about half the temperature of thermal oxidizers, catalytic units have smaller physical footprints and may offer lower operating costs in certain circumstances. Since catalysts are employed, these systems are subject to catalyst poisoning or deactivation due to operating upset and may require periodic catalyst replacement, which represents a substantial operating cost.

Other industries have demonstrated typical VOC removal efficiencies of up to 98%. The District considers catalytic thermal oxidation as technologically feasible for application to brandy aging and wine aging and that a control efficiency of 98% is reasonably achievable.

3.   Adsorption Vapor Recovery

Adsorption vapor recovery is accomplished by passing the VOC-laden gas through beds containing adsorbents that have a high surface area to weight ratio. Typical adsorbents are activated carbon, zeolite, or organic polymers. As the gas stream passes through the bed, organic compounds adsorb weakly onto the adsorbent's surface. Adsorption of the hydrocarbon molecules proceeds until the available surface area is filled or saturated with VOC molecules. The VOC molecules are retained until the regeneration step, or disposal of the spent adsorbent.

Desorbing or removing captured VOCs regenerates the adsorbent. Decreasing the pressure, reducing the hydrocarbon concentration around the adsorbent or increasing the temperature of the bed can perform regeneration. A combination of these steps can also be used for regeneration. There are three basic types of adsorption systems available to recover or remove hydrocarbon vapors from an air stream. Two of these systems regenerate the adsorbent in-situ for reuse. The third system requires removal of the adsorbent to another site for regeneration.

The two systems that provide in-situ regeneration are: Pressure Swing Regenerated Systems and Thermally Regenerated Systems (or a combination of the two methods). Since the net result of the combined adsorption and regeneration process only results in transfer of the ethanol from the vent stream to another liquid or gaseous stream, further treatment of the effluent of the regeneration process is required to either destroy or recover the ethanol (typically thermal oxidation of the stripping gas stream or water treatment in the case of steam stripping).

The District considers adsorption vapor recovery (with appropriate handling of regeneration waste streams) as technologically feasible for application to brandy aging and wine aging. Based on a draft technical assessment document (TAD) prepared by the ARB, a control efficiency of 95% is considered reasonable for adsorption systems when controlling ethanol emissions (from wine fermentation), a more demanding application due to the presence of large amounts of CO_2.

4.   Wet Scrubbing (Absorption)

The basic process involved in wet scrubbing is the contact of a polluted gas stream with a liquid solution. During operation, gas flows upward through a column containing packing or other mass transfer media. The scrubbing liquid is delivered to the top of the column and flows down (by gravity) through the porous mass transfer media, generating a substantial interfacial surface area between the gas and liquid phases in a counter

flow arrangement which provides optimal mass transfer. Gaseous contaminants are absorbed into the liquid and the decontaminated gas stream flows out of the scrubber.

Many scrubbing applications achieve emission reduction efficiencies of 99.9%. In a pilot study conducted by the ARB in 1987, wet scrubbing demonstrated greater than 90% reduction in ethanol emissions when operated for control of ethanol emissions (from wine fermentation tanks). The District considers wet scrubbing as technologically feasible for application to brandy aging and wine aging and that a control efficiency of 90% is reasonably achievable.

5.   Condensation, Refrigeration, and Cryogenic Systems

Condensation, refrigeration, and cryogenic systems remove organic vapor by condensing the target gases on cold surfaces. These cold conditions can be created by passing cold water through an indirect heat exchanger, by spraying cold liquid into an open chamber with the gas stream, by using a refrigerant to create very cold coils, or by injecting cryogenic gases such as liquid nitrogen into the gas stream. The concentration of VOCs is reduced to the level equivalent to the vapor pressures of the compounds at the operating temperature. Removal efficiencies attainable with this approach depend strongly on the outlet gas temperature. For cold-water-based condensation systems, the outlet gas temperature is usually in the 40 to 50°F range, and the VOC removal efficiencies can be in the 90% to 99% range depending on the vapor pressures of the specific compounds. For refrigerant and cryogenic systems, the removal efficiencies can be considerably above 99% due to the extremely low vapor pressures of essentially all VOC compounds at the very low operating temperatures of -70°F to less than -200°F. Water vapor content in the gas stream may place a lower limit on the outlet gas temperature due to potential ice formation.

The application of refrigerated condenser to the control of ethanol emissions (from a fermentation tank) was examined by ARB. The results of that study indicated that a 90% ethanol recovery could be achieved at an outlet gas temperature of -12 °F when controlling ethanol emissions. However, it was noted that ice formation could be a problem at this temperature and that special equipment designs would be required for reasonable operation. In addition, the ethanol is recovered in aqueous solution and must be further process for recovery of the ethanol. The District considers refrigerated condensation as technologically feasible for application to brandy aging and wine aging and that a control efficiency of 90% is reasonably achievable.

6.   Biological Oxidation

VOCs can be removed by forcing them to absorb into an aqueous liquid or moist media inoculated with microorganisms that consume the dissolved and/or adsorbed organic compounds. The control systems usually consist of an irrigated packed bed that hosts the microorganisms (biofilters). A presaturator is often placed ahead of the biological system to increase the gas stream relative humidity to more than 95%. The gas stream

temperatures are maintained at less than approximately 105°F to avoid harming the organisms and to prevent excessive moisture loss from the media.

Biological oxidation systems are most often used for very low concentration VOC-laden gas streams for odor control. The VOC inlet concentrations are often less than 500 ppmv and sometimes less than 100 ppmv and achieve control efficiencies exceeding 95%. However, biofilters have been demonstrated in industrial applications achieving 90% control efficiency when controlling higher ethanol inlet concentrations (up to 3 g/1000 m^3). The District considers biological oxidation to be technologically feasible for application to brandy aging and wine aging and that a control efficiency of 90% is reasonably achievable.

C.   Emission Reductions

The 2007 Ozone Plan estimates a 2012 brandy aging and wine aging VOC emission baseline of 2.30 tons per day. This value has been adjusted to account for 4.5 tons per day of reductions from facilities that are part of alternative compliance options in Rule 4694 (Wine Fermentation and Storage Tanks). These emissions are SIP creditable to previous 1-Hour Ozone Plan commitments for the Brandy and Wine Aging (S-IND-14) control measure. Approximately 98 percent of the brandy aging emissions in the San Joaquin Valley (four facilities) are already controlled in accordance with the requirements of this rule. Implementation of this rule is expected to require emission controls on one additional brandy aging facility, resulting in an annual emission reduction of 0.12 tons per day attributable to this rule for brandy aging. The wine aging emission reductions are currently achieved in practice and are considered RACT and are not creditable to this rule.

As previously stated in this Draft Staff Report, the District sought as much reduction of VOC emissions from brandy aging and wine aging as expeditiously as practicable, technologically feasible, and economically reasonable, as determined by the District's Governing Board. The VOC emissions reduction analysis is presented in Appendix B of the Final Draft Staff Report and also includes stakeholder submitted data.

V.   COST EFFECTIVENESS ANALYSIS

Pursuant to CH&SC section 40920.6(a), a cost effectiveness analysis is required for rules that implement RACT. The purpose of the cost effectiveness analysis is to evaluate the economic reasonableness of the rule or rule amendments. The analysis also serves as a guideline for developing the control requirements of the rule. District staff has conducted a cost effectiveness analysis for Rule 4695. The cost effectiveness analysis is presented in Appendix C of the Final Draft Staff Report.

VI.   SOCIOECONOMIC ANALYSIS

Pursuant to CH&SC 40728.5, "whenever a district intends to propose the adoption, amendment, or repeal of a rule or regulation that will significantly affect air quality or emissions limitations, that agency shall, to the extent data are available; perform an assessment of the socioeconomic impacts of the adoption, amendment, or repeal of the rule or regulation." The socioeconomic impact of Rule 4695 is presented in Appendix D of the Final Draft Staff Report.

VII.   RULE CONSISTENCY ANALYSIS

Pursuant to the state Health and Safety Code, Section 40272.2, District staff has prepared a rule consistency analysis of Rule 4695. The Rule Consistency Analysis is presented in Appendix E of the Final Draft Staff Report.

VIII.   ENVIRONMENTAL IMPACTS

Pursuant to the California Environmental Quality Act (CEQA), District staff investigated the possible environmental impacts of the proposed Rule 4695. Based on the Initial Study District staff concluded that the proposed rule will not have any significant adverse effects on the environment. Staff recommends filing a Negative Declaration under the provisions of the Public Resource Code 15061 (b) (3) to be presented to the Governing Board Chair for signature.

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APPENDIX A

SUMMARY OF SIGNIFICANT COMMENTS
AND DISTRICT RESPONSES
FOR
PROPOSED RULE 4695

September 17, 2009

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Summary of Significant Comments and District Responses for Proposed Rule 4695 and Final Draft Staff Report dated September 17, 2009

US EPA REGION IX STAFF COMMENTS
ARB STAFF COMMENTS
STAKEHOLDER COMMENTS

The proposed rule was published on August 17, 2009 and no comments were received when the comment period ended at 5:00 pm PDT on August 31, 2009.

APPENDIX B

PRELIMINARY EMISSION REDUCTION ANALYSIS
FOR
PROPOSED RULE 4695

September 17, 2009

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APPENDIX B
Emission Reduction Analysis

I.   SUMMARY

This appendix details the estimated volatile organic compounds (VOC) emission reductions for the controls proposed in the proposed Rule 4695 (Brandy Aging and Wine Aging).

The 2007 Ozone Plan estimates a 2012 brandy and wine VOC emission baseline of 2.30 tons per day. This baseline accounts for a total of 4.5 tons per day of reductions from facilities that are part of alternative compliance options for Rule 4694 (Wine Fermentation and Storage Tanks). Those reductions are SIP creditable to previous 1-Hour Ozone Plan commitments) for the Brandy and Wine Aging (S-IND-14) control measure. Approximately 98 percent of the brandy aging emissions in the San Joaquin Valley (four facilities) are already controlled in accordance with the requirements of this rule.

Implementation of this rule is expected to require emission controls on one additional brandy aging facility, resulting in an annual emission reduction of 0.12 tons per day attributable to this rule for brandy aging. The wine aging RACT emission controls are considered to be currently achieved in practice at the affected facilities so no additional emission reductions would accrue from those requirements.

II.   BACKGROUND

District staff is proposing to implement VOC control requirements for Major Sources, i.e., facilities with a Stationary Source Potential to Emit of 10 tons per year or more, which conduct brandy aging and wine aging operations. The particular level of control required for the aging operation depends on the level of emissions from the operations, not from the total emissions from the Stationary Source.

III.   EMISSION REDUCTION ANALYSIS

Reductions from Brandy Aging

Based on the District's survey, there is currently only one larger brandy aging operation in the District which does not have BARCT VOC emission controls pursuant to this rule. Based on information provided by that facility, the District has determined that this operation currently has Uncontrolled Aging Emissions (UAE) of 47.3 tons per year or 0.13 tons per day.

The following equation was used to calculate the facility's UAE.

$$UAE = TAAI * AEF$$

Where:
UAE =   Uncontrolled Aging Emissions, in pounds of ethanol per year.
TAAI =   Total Annual Aging Inventory, in gallons of brandy per year.
AEF =   Aging Emission Factor, in pounds of ethanol per gallon of brandy.

Brandy AEF = 3 proof gallons loss/50 gallon barrel x 0.5 gallons ethanol/ proof gallons x 6.616 lb ethanol/gallon.

The brandy AEF uses the 3 proof gallons loss/50 gallon barrel as the default value. This value is after warehouse refrigeration and is accepted by the industry and is used by the District in the permitting process.

Reductions from Wine Aging

Per the District's survey there are a number of uncontrolled wine aging operations in the District. The survey includes both barrel aging operations and large wooden storage tanks located at wineries. The basis and assumptions for estimating emissions from these sources are as follows:

Annual emissions from wine aging (tons per year) = (L x I x P x D) ÷ 2,000 lb/ton

Where
L =   Percentage wine loss per year (assumed to be 3%, as discussed in the Staff Report)
I =   Average annual wine aging inventory, in gallons (2007 year data)
P =   Average ethanol content of the aged wine:
       (For wines with <14% Alcohol by Volume (ABV), P = 14%;
       For wines with >14% ABV, P = 19%)
D =   Density of pure ethanol 6.6 in lb/gallon

Table 1, below, shows the results of applying the above formula to the various wine aging operations in the Valley.   As explained elsewhere in the Staff Report, all facilities are expected to be in compliance with the RACT and Additional RACT requirements of this rule so no additional emission reductions will result from those requirements. Also, the addition of BARCT level controls was deemed to be too costly so no additional BARCT controls will be required and no additional emission reductions will be generated from wine aging operations.

Table 1 – Fugitive VOC Emissions from Wine Aging for 2007.					
Facility No.	Gallons Stored <14% ABV	Gallons Stored >14% ABV	Total Gallons	Emissions <14% tpy	Emissions >14% tpy	Emissions Facility tpy
*1	1,770,000	0	1,770,000	11.45	0	11.45
2	0	198,900	198,900	0	3.75	3.75
3	0	193,000	193,000	0	3.65	3.65
4	104,460	46,860	151,320	1.45	0.9	2.35
5	113,687	18,916	132,603	1.6	0.35	1.95
6	20,000	60,000	80,000	0.3	1.15	1.45
7	46,728	23,364	70,092	0.65	0.45	1.1
8	13,629	45,002	58,631	0.2	0.85	1.05
9	1,475	45,525	47,000	0	0.85	0.85
10	0	14,800	14,800	0	0.3	0.3
11	8,500	6,200	14,700	0.1	0.1	0.2
12	1,379	8,917	10,296	0	0.15	0.15
13	6,000	4,000	10,000	0.1	0.1	0.2
14	6,608	767	7,375	0.1	0	0.1
15	3,120	0	3,120	0.05	0	0.05
16	1,500	1,500	3,000	0.02	0.03	0.05
17	0	2,459	2,459	0	0.05	0.05
18	710	270	980	0	0	0
19	120	600	720	0	0	0
20	320	320	640	0	0	0
21	0	250	250	0	0	0
22	180	0	180	0	0	0
Totals	2,098,416	671,650	2770066	16.02	12.68	28.70

* Using stakeholder evaporative loss rate of 1.4% by volume, all others use 3% by volume.

Reductions from Brandy Aging

Summarizing the expected and calculated emission reduction from BARCT:

A.   Emission Reductions = current emissions x implementation control efficiency.

B.   Implementation Control Efficiency (90%) = 92% PTE criteria x 98% control efficiency

Therefore,

Emission Reduction from Brandy Aging = 47.3 tons/year x 90%
                                                        = 42.6 tons per year

Emission Reduction from Wine Aging will be zero because all facilities are already complying with RACT or and Additional RACT level control requirements. Therefore, as seen in Table 2, emission reductions associated with Rule 4695 will be 0.12 tons per day.

Table 2 Emission Reductions for Rule 4695		
Operation	Emission Reductions	
	Tons per Year	Tons per Day
Brandy Aging	42.6	0.12
Wine Aging	0	0
Total	42.6	0.12

APPENDIX C

COST EFFECTIVENESS ANALYSIS
FOR
PROPOSED RULE 4695

September 17, 2009

APPENDIX C
Cost Effectiveness Analysis

I.   INTRODUCTION

The California Health and Safety Code (CH&SC) 40920.6(a) requires the San Joaquin Valley Unified Air Pollution Control District to conduct both an "absolute" cost effectiveness analysis and an "incremental" cost effectiveness analysis of available emission control options prior to adopting each Best Available Retrofit Control Technology (BARCT) rule. The purpose of conducting a cost effectiveness analysis is to evaluate the economic reasonableness of the pollution control measure or rule as it applies to operators in the San Joaquin Valley Air Basin. The analysis also serves as a guideline in developing the control requirements of a rule.

II.   SUMMARY AND CONCLUSION

Wine Aging

An emissions capture and control system consisting of a Permanent Total Enclosure (EPA Method 204) and an emissions control device (regenerative thermal oxidizer) was found to offer a cost effectiveness of $26,700 per ton for wine aging operations with uncontrolled Potential to Emit of 30 tons-ethanol per year or more. Since thermal oxidation offers a VOC destruction efficiency (98%) which is greater than that of the other available control technology options, an incremental cost effectiveness analysis was not applicable.

Brandy Aging

An emissions capture and control system consisting of a Permanent Total Enclosure (EPA Method 204) and an emissions control device (regenerative thermal oxidizer) was found to offer a cost effectiveness of $24,600 per ton for brandy aging operations with uncontrolled Potential to Emit of 4 tons-ethanol per year or more. Since thermal oxidation offers a VOC destruction efficiency (98%) which is greater than that of the other available control technology options, an incremental cost effectiveness analysis was not applicable.

III.   COST EFFECTIVENESS ANALYSIS

Introduction

District staff used available technical and cost information contained in technical reports, EPA's Air Pollution Control Cost Manual, District permit files for existing brandy aging operations and information supplied by equipment manufacturers and the wine and brandy aging industry to conduct a cost effectiveness analysis of the proposed requirements of Rule 4695.

A previous review of the available VOC control technologies has indicated that the following would be potentially applicable to the control of ethanol emissions from wine and brandy aging operations:

1.   Thermal Oxidation (conversion of the VOC to CO_2) – 98% Control Efficiency (CE)

2.   Catalytic Oxidation (conversion of the VOC to CO_2) – 95% Control Efficiency (CE)

2.   Absorption ("scrubbers", which transfer the VOC in air emissions to a liquid waste stream) – 90% CE

3.   Adsorption (often using activated carbon, which transfers the VOC in the air onto a solid substrate) – 95% CE

4.   Condensation (conversion of the VOC gases into liquids) – 90% CE

5.   Biological control systems (e.g., bio-filters or bio-scrubbers) – 90% CE

While any of the above technologies could potentially be applied for control of VOC emissions from wine and brandy aging facilities, this cost effectiveness analysis will be based only on the use of regenerative thermal oxidation (RTO) technology due to:

- All existing brandy aging facilities in the San Joaquin Valley which have been modified to install controls have used RTO technology. As of the date of this analysis, six brandy aging warehouses in the District, which represent in excess of 95% of the brandy aging capacity in the San Joaquin Valley, have been retrofit with RTO-based VOC controls.

- The wine and brandy aging industry in the San Joaquin Valley has indicated a preference for RTO technology for both wine and brandy aging operations and all cost information which has been supplied by the industry to support this analysis is based on use of an RTO.

- Thermal and catalytic oxidation, condensation, and biological control were previously found to offer similar cost effectiveness in this application while absorption and adsorption were found to be significantly more expensive due to operating costs associated with either waste water disposal or regeneration of spent activated carbon. In general, it has been found that the cost effectiveness analysis is relatively insensitive with respect to selection of the control device largely due to the significant costs associated with the PTE, ducting, induced draft

fan, instrumentation and other scope items which are independent of the control technology selection. No control technology was found to offer better cost effectiveness than RTO technology largely due to its low operating cost (high thermal efficiency). Therefore, the evaluation can be based on RTO technology without a loss of generality.

- An RTO provides the highest thermal efficiency and lowest collateral emissions of NO_x and greenhouse gases when compared to other types of thermal oxidation systems.

In addition, all potential control options listed above are classified as capture and control systems and therefore all share a common requirement for a capture system consisting of an enclosure for the barrel aging operation, ducting and an induced draft fan to deliver the captured emissions from the enclosure to the control device. Based on the existing brandy storage operations currently operating within the District, an enclosure that meets the criteria for a Permanent Total Enclosure (PTE), pursuant to U.S. EPA Method 204, is considered to be an Achieved-in-Practice capture system for wine and brandy aging. By definition the capture efficiency for a PTE is considered to be 100%. However, since wine and brandy aging operations (and their emissions) are a continuous 24 hour/day operation throughout the year, it would be difficult and expensive to continuously maintain the warehouse in "PTE" status due to on-going requirements to transport product into and out of the warehouse and due to requirements for maintenance during which the warehouse must be opened or the control device must be shut down. During such periods, uncontrolled emissions are delivered to the atmosphere in the absence of expensive air lock systems and redundant control devices.

As mentioned above, all existing brandy aging facilities in the District utilize an RTO for the control device. Additionally, based upon existing brandy aging operations currently permitted in the SJV, the District has determined that a PTE in this application can achieve an on-line availability of 95%, i.e., access and maintenance requirements will not exceed 5% of the total operating time for the warehouse. Annual downtime for control device maintenance is potentially 10 days per year during which time the emissions are also uncontrolled. Overall capture and control efficiency (CCE) is thus calculated as:

CCE = CE x (days on-line per year) ÷ (total days per year)

CCE = CE x (365 - 10 - 5% x (365 - 10)) ÷ 365 = CE x 92%

Since this analysis will only consider thermal oxidation, CE = 98%. Therefore,

CCE = 98% x 92% = 90.2%

Basis and Assumptions

The following are assumptions used for the cost effectiveness analysis:

1. Existing wine and brandy aging operations are assumed to be conducted in 59 and 50 gallon wooden barrels respectively, stored in dedicated warehouses. The warehouse construction typically features concrete tilt-up walls with insulated wood-frame roof covered with composition roofing. The warehouse space is commonly conditioned with refrigerated air conditioning and humidification to minimize evaporative loss during the aging process.

2. Wine loss from barrel storage is 1.4% per year for wine aging warehouses with conditioned storage space based on data provided by industry. Average ethanol content is assumed to be 14 vol% yielding an emission factor of 0.764 lb-VOC per 59 gallon barrel per year.

3. The emission factor for brandy aging is 9.93 lb-VOC per barrel per year based on an average loss of 3 proof gallons per year per 50 gallon barrel for permitted facilities in the SJV and 3.31 lb-ethanol per proof gallon.

4. The Total Capital Investment (TCI) for installation of controls on wine or brandy aging operations is based on the following scope:

   • Modify an existing warehouse to convert it to a PTE for wine or brandy aging.
   • Install a control device equipment package consisting of the control device, a variable speed controlled induced draft fan, and stack with associated interconnecting ducting, controls and instrumentation.
   • Install ducting as required for collection of emissions and connection of the PTE to the control device package.

5. Warehouse size in square feet, as a function of the number of barrels stored, was determined based on the typical existing warehouse floor space versus barrel capacity for brandy aging operations currently permitted by the District. Based on typical industry practice, it was assumed that wine barrels are stored in metal racks in horizontal position and stacked up to 6 barrels high. For brandy, the barrels are palletized and stacked vertically up to six barrels high. A wine aging warehouse with an uncontrolled Potential to Emit of 30 tons per year was determined to consist of a 150,800 square feet warehouse space housing 78,493 barrels (59 gallons each). A brandy aging warehouse with an uncontrolled Potential to Emit of 4 tons per year was determined to consist of a 2,940 square feet warehouse space housing 806 barrels (50 gallons each).

6. Determination of the required air flow capacity per square foot of warehouse space (for estimation of electricity and fuel consumption) was made based on rated air flow

capacities of existing brandy aging facilities currently permitted by the District. Since the air rate is primarily set by the ability to seal the existing structure to minimize the air flow, the rated capacities as determined from the brandy operations are assumed to be applicable to wine aging as well. Using typical values, rated air flow for a 150,800 ft^2 warehouse was estimated at 9,950 scfm (66 scfm/1000 sq ft). Rated air flow for a 2,940 ft^2 warehouse was estimated at 280 scfm (95 scfm/1000 sq ft).

5. The actual detailed scope and the associated actual Total Capital Investment which was required for a previous conversion of two large existing brandy aging warehouses to PTE's and the installation of RTO-based controls on these warehouses was provided to the District by the Wine Institute as confidential information. District staff applied the "six tenths factor rule" (a commonly used estimating technique) to the industry supplied cost data to estimate the Total Capital Investment required for the specific size of operations being evaluated. Per the "six-tenths-factor rule", if a new piece of equipment is similar to one of another capacity for which cost data are available, the cost of the new unit with X times the capacity of the first is approximately $(X)^{0.6}$ times the cost of the initial unit:

Cost of equip. A = cost of equip. B $\big((cap.\ of\ equip.\ A)/\ (cap.\ of\ equip.\ B)\big)^{0.6}$

Applying this equation to the two cases in this analysis yields:

TCI (150,800 ft^2) = \$2,469,400 x (150,800 ft^2/155,600 ft^2)$^{0.6}$ = \$2,423,400

TCI (2,940 ft^2) = \$2,469,400 x (150,800 ft^2/2,940 ft^2)$^{0.6}$ = \$228,200

6. Annual Cost was estimated in accordance with the cost estimation template provided in the EPA Control Cost Manual, Table 2.10 with the following exceptions:

- Unit costs given in Table 2.10 for labor were escalated to 2009 at a rate of 3% per year.
- Annual maintenance cost was estimated at 3% of TCI based on typical ranges given by Peters & Timmerhaus[1].

7. The Capital Recovery Factor is 0.163 based on 10-year amortization at 10% annual interest rate.

8. Electricity cost was calculated for the energy consumption by the induced draft fan, based on the rated flow of the RTO, a pressure differential of 10 "WC, fan efficiency of 65% and electric motor efficiency of 90%. A unit price of \$0.12 per kWh was applied based on published average rates for California.

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[1] Peters, Max and Klaus Timmerhaus, Plant Design and Economics for Chemical Engineers, McGraw-Hill, New York, 1968, p. 132.

9. Natural gas requirements were estimated based on the following:
   - The RTO operates at 1,400 °F
   - Thermal efficiency is 95%
   - Ethanol is assumed to provide 50% of the thermal requirements for brandy operation and 8% is assumed for wine operations.
   - Natural gas is priced at $8.00/MMBtu based on the average published NYMEX Henry-Hub price for 2008.

Cost Effectiveness Analysis

Table 1 presents the evaluated Total Capital Investment (TCI), Annual Cost and the Cost Effectiveness each for the wine and brandy operations. As shown, a cost effectiveness of $26,700 per ton is applicable to the installation of VOC controls on a wine aging warehouse with an uncontrolled Potential to Emit of 30 tons per year. A cost effectiveness of $24,600 per ton is applicable to the installation of VOC controls on a brandy aging warehouse with an uncontrolled Potential to Emit of 4 tons per year.

Table 1

Cost Effectiveness for Wine and Brandy Aging Warehouses		
Case	**Wine Aging Warehouse**	**Brandy Aging Warehouse**
Uncontrolled PE, tons per year	30.0	4
Warehouse Size ft2	150,800	2,940
Barrel Aging Capacity (bbls)	78,493	806
Total Capital Investment (TCI)	$2,423,400	228200
Direct Annual Costs		
Operating Labor (0.5 hr/shift @ $28.35/hr))	$15,500	$15,500
Supervision @ 15%	$2,300	$2,300
Operating Materials @ 15% of maintenance	$10,900	$1,000
Maintenance @ 3% of TCI	$72,700	$6,800
Utilities		
Natural Gas	$48,700	$700
Electricity	$21,000	$600
Total Direct Cost (TDC)	$171,100	$26,900
Indirect Annual Cost		
Overhead @ 60% of Operating Labor and Maintenance	$60,800	$15,400
Administrative Charges, 2% TCI	$48,500	$4,600
Property Tax, 1% TCI	$24,200	$2,300
Insurance, 1% TCI	$24,200	$2,300
Capital Recovery (CRF = 0.163)	$395,000	$37,200
Total Indirect Annual Cost (TIAC)	$552,700	$61,800
Total Annual Cost (TDC + TIAC)	$723,800	$88,700
Destruction Efficiency %	90.2%	90.2%
Annual Emissions Reduction - tons	27.06	3.61
Cost Effectiveness ($ per ton)	$26,700	$24,600

APPENDIX D

DRAFT SOCIOECONOMIC IMPACT ANALYSIS REPORT
FOR
PROPOSED RULE 4695

September 17, 2009

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DRAFT RULE 4695 (WINE & BRANDY): SOCIOECONOMIC IMPACT ANALYSIS

JULY 29, 2009

D-3

*Final Draft Staff Report with Appendices
For Proposed Rule 4695*

CONTENTS

EXECUTIVE SUMMARY

Proposed Draft New Rule 4695 codifies the requirement for VOC emission controls which have been installed by wine fermentation operators under Rule 4694's alternative emission reduction option. This rule would specify RACT for major sources as the means to achieve the maximum amount of VOC emission reductions by using control technologies that are reasonably available. Any VOC emissions reduction from the control of brandy aging have already been accounted for by Rule 4694 and are not considered to be additive for SIP purposes. This rule applies to all brandy aging and wine aging facilities but does not require emission controls for those facilities which have a Stationary Source Potential to Emit of less than 10 tons per year.

The proposed new rule will affect two entities operating in the region. The report finds that these entities are not significantly impacted by the proposed draft new rule.

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INTRODUCTION

The San Joaquin Valley Unified Air Pollution Control District ("District") seeks to adopt proposed Draft New Rule 4695 to implement emission control requirements listed in the 2007 Ozone Plan as well as the 2008 PM 2.5 The report is prepared pursuant to the provisions of AB2051 (Section 40728.5 of the California Health and Safety Code), which requires an assessment of socioeconomic impacts of proposed air quality rules. The findings in this report can assist District staff in understanding the socioeconomic impacts of the proposed Draft New Rule 4695, and can assist staff in preparing a refined version of the rule. Figure 1 is a map of the eight-county region that comprises the San Joaquin Valley Air Basin. As indicated in the map, Kern County is not completely in the District.

FIGURE 1
MAP OF SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT
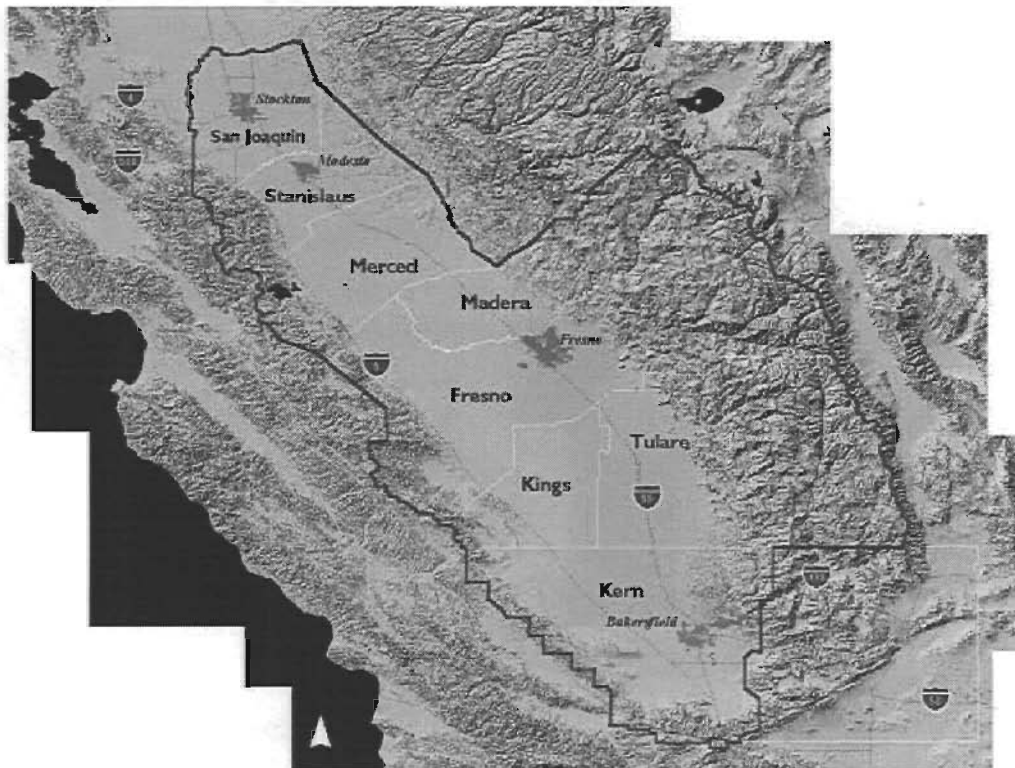
Source: ADE, Inc.

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SECTION 1. OVERVIEW OF DRAFT WINE & BRANDY RULE

Proposed Draft New Rule 4695 codifies the requirement for VOC emission controls which have been installed by wine fermentation operators under Rule 4694's alternative emission reduction option. This rule would specify RACT for major sources as the means to achieve the maximum amount of VOC emission reductions by using control technologies that are reasonably available. Any VOC emissions reduction from the control of brandy aging have already been accounted for by Rule 4694 and are not considered to be additive for SIP purposes. This rule applies to all brandy aging and wine aging facilities but does not require emission controls for those facilities which have a Stationary Source Potential to Emit of less than 10 tons per year.

EXISTING CONDITIONS

There are no existing rules in the nation that require controlling VOC emissions from brandy aging and wine aging operations. Rule 4623 (Storage of Organic Liquids) limits VOC emissions from the storage of organic liquids. The EPA originally proposed a limited approval/limited disapproval of Rule 4623, citing deficiencies in Rule 4623 that conflict with Section 110 of the federal Clean Air Act (CAA). Although not identified as a rule deficiency, EPA expressed concern that the rule provides an exemption for tanks used in wine fermentation and storage of resulting products, by-products, and spirits. EPA considers VOC emissions from this source category to be significant and recommended further study and analysis. The District Governing Board subsequently adopted amendments to Rule 4623 in order to correct the rule deficiencies identified by EPA.

Rule 4694 (Wine Fermentation and Storage Tanks) requires installation and operation of VOC emission control system to reduce emissions from wine fermentation and storage operations. As an alternative to controlling the emissions from wine fermentation and storage tanks, Rule 4694 allows operators to mitigate fermentation emissions by controlling alternative emission sources (i.e., reductions in surplus emissions from mobile sources, area sources, or stationary sources) with the expectation that reductions would be permanent. In lieu of installing VOC control devices to wine fermentation tanks to fulfill the Rule 4694 requirements, operators voluntarily offered to control surplus emissions from brandy aging operations to obtain equivalent reductions which could then be creditable as Certified Emissions Reduction Credits (CER) to the wine fermentation Rule 4694.

To attain the CER, operators of brandy aging facilities modified existing brandy aging warehouses to meet the requirements for a Permanent Total Enclosure as specified in EPA Test Method 204. This enabled ethanol emissions to be captured and destroyed using regenerative thermal oxidizer technology. Until the successful demonstration that the

operation of the capture and control system will not result in unacceptable impacts on brandy quality, consistency, or volume loss; the conditions of the operating permits are provisional, and subject to revisions.

PROPOSED DRAFT NEW RULE 4695

The District staff prepared a report that discusses in detail elements to proposed Draft New Rule 4695 ("Draft Staff Report for New Draft Rule 4695", April 2009). Below is a list of changes associated with the proposed new draft rule.

Section 3.0 – Definitions
Section 4.0 – Exemptions
Section 4.1 Operation Exemption
Section 5.0 – Requirements
Section 5.1 Thresholds
Section 5.1.1 Meeting PTE Requirements
Section 5.1 Demonstrating PTE
Section 5.1.2 Continuous Negative Pressure Maintenance
Section 5.1.5 Continuous, Automatic, Monitoring System
Section 5.2 Routine Maintenance Down Time And Capture Efficiency
Section 5.3.1 CEMS/Alternate Monitoring Scheme
Section 5.3.2 Operation, Demonstration of Continuous, Automatic, Monitoring System
Section 6.0 – Administrative Requirements
Section 6.1 Recordkeeping
Section 6.2.1 – 6.2.4 Compliance Testing
Section 6.2.5 Test Methods
Section 6.3 Compliance Testing

SECTION 2. METHODOLOGY

The socioeconomic analysis involves the use of information provided directly by affected sources, as well as secondary data used to describe the industries affected by the proposed new Draft Rule 4695. The approach is briefly described below.

Applied Development Economics (ADE) began the analysis by preparing a statistical description of the industry groups of which the affected sources are a part, analyzing data on the number of jobs, sales levels, the typical profit ratios and other economic indicators for each industry.

This report relies heavily on the most current data available from a variety of sources, such as the Dun and Bradstreet, 2002 Economic Census and the State of California's Employment Development Department (EDD) Labor Market Information Division. In addition, ADE utilized data from California Department of Conservation and the California Energy Commission. For purposes of estimating profits, ADE reviewed a number of sources, including Dun and Bradstreet, the CCH, Inc., the US Internal Revenue Services, and corporate annual reports of companies subject to Rule 4695.

With the above information, ADE was able to estimate net after tax profit ratios for sources affected by the proposed amendments. ADE calculated ratios of profit per dollar of revenue for affected industries. The result of the socioeconomic analysis shows what proportion of profits the compliance costs represent. Based on assumed thresholds of significance, ADE discusses in the report whether the affected sources are likely to reduce jobs as a means of recouping the cost of rule compliance or as a result of reducing business operations. To the extent that such job losses appear likely, the indirect multiplier effects of the jobs losses are estimated using a regional IMPLAN input-output model.

When analyzing the socioeconomic impacts of proposed new rules and amendments, ADE works closely within the parameters of accepted methodologies discussed in a 1995 California Air Resources Board report called "Development of a Methodology to Assess the Economic Impact Required by SB513/AB969" (by Peter Berck, PhD, UC Berkeley Department of Agricultural and Resources Economics, Contract No. 93-314, August, 1995). The author of this report reviewed a methodology to assess the impact that California Environmental Protection Agency proposed regulations would have on the ability of California businesses to compete. The California Air Resources Board (ARB) has incorporated the methodologies described in this report in its own assessment of socioeconomic impacts of rules generated by ARB. One methodology relates to determining a level above or below which a rule and its associated costs is deemed to have significant impacts. When analyzing the degree to which its rules are significant or insignificant, ARB employs a threshold of significance that ADE follows. Berck reviewed the threshold in his analysis and wrote, "The Air Resources   Board's (ARB) use of a 10 percent change in

[Return on Equity] ROE (i.e. a change in ROE from 10 percent to a ROE of 9 percent) as a threshold for a finding of no significant, adverse impact on either competitiveness or jobs seems reasonable or even conservative."

SECTION 3. IMPACTED INDUSTRIES SUBJECT TO DRAFT RULE 4695

This section of the socioeconomic analysis describes demographic and economic trends in the San Joaquin Valley region. The first part of this section compares the San Joaquin Valley region against California as a whole, and provides a context for understanding demographic and economic changes that occurred within the San Joaquin Valley region between 1998 and 2008. Starting with sub-section 3.3, the second part of this section narrows the focus of the socioeconomic analysis to industries affected by the proposed amendments to proposed New Draft Rule 4695.

3.1 REGIONAL DEMOGRAPHIC RULES

The San Joaquin Valley region experienced tremendous population growth during the 1990s. Many came to this area because of affordable housing. As a result, population increased significantly. The eight-county region's population increased by 24 percent (or approximately 2.2 percent annually), from 3.2 million in 1998 to 3.9 million in 2008. In the last five years, population growth rate slightly declined, as regional population grew by 2.2 percent annually between 2003 and 2008. While the State of California's population increased by 14 percent (or approximately 1.4 percent annually) between 1998 and 2008, all the counties in the region experienced faster rates of growth than California over the period, as Table 1 shows. While, by many standards, a small county of 150,887 residents, Madera County experienced an annual growth rate of 2.8 percent between 1998 and 2008. Between 2003 and 2008, this county continued to grow annually but at a slightly lesser rate of 2.7 percent. In the same five-year period, Kern, Merced, and San Joaquin Counties experienced rapid growth, growing annually by 2.9 percent, 2.4 percent, and 2.2 percent respectively, as Table 1 below shows. As demonstrated in the following section on regional economic trends, the demographic changes that occurred in the San Joaquin Valley region during the 1990s and into the new century significantly influenced the economy of this eight-county region.

TABLE 1
POPULATION TRENDS

	1998	2003	2008	98-03	03-08	98-08
State	33,225,655	35,652,700	38,049,462	1.4%	1.3%	1.4%
Region	**3,192,439**	**3,540,392**	**3,956,003**	**2.1%**	**2.2%**	**2.2%**
Fresno	781,936	846,485	931,098	1.6%	1.9%	1.8%
Kern	637,227	708,753	817,517	2.2%	2.9%	2.5%
Kings	120,957	137,411	154,434	2.6%	2.4%	2.5%
Madera	114,137	131,821	150,887	2.9%	2.7%	2.8%
Merced	203,181	227,132	255,250	2.3%	2.4%	2.3%
San Joaquin	546,852	616,477	685,660	2.4%	2.2%	2.3%
Stanislaus	428,272	483,705	525,903	2.5%	1.7%	2.1%
Tulare	359,877	388,608	435,254	1.5%	2.3%	1.9%

Source: ADE, Inc., based on California Department of Finance

3.2 REGIONAL ECONOMIC TRENDS

Economic development practitioners and planners have traditionally divided economies into two broad industrial categories—the economic base and local support industries. Economic base industries are the drivers of local and regional economies in that these industries draw income into a local economy by selling products outside of the local economy, much like the export industries of a national economy. Accrued earnings then circulate throughout the local area in the form of wages and salaries; investments; purchases of fixed assets, goods, and services; and generation of more jobs and wealth.

The economic base is typically comprised of industries within the manufacturing, minerals-resource extraction, and agricultural sectors. There are also the "local support industries" such as retail or service sectors, the progress of which is a function of the economic base and demographic changes, and more so the latter than the former. As population increases in a given area, demand for services—such as realtors, teachers, and healthcare—increases, as does demand for basic retail items like groceries, gas for commuting, or clothing at the local apparel shops.

Agriculture is the economic base of the San Joaquin Valley region by virtue of the amount of goods this sector produces and exports throughout the nation and the globe. Slightly less than 14 percent of all workers in the region are employed by industries within agriculture, as Table 2 shows. In 1998, approximately 13.1 percent of all workers worked in agriculture. By 2003, this ratio stood at 14 percent. In fact, over the five-year period between 2003 and 2008, employment in agriculture increased at a modest pace of one percent per year.

Between 2003 and 2008, local support industries gained in prominence within the San Joaquin Valley region. Service-rendering industries employed the most workers as a proportion of total employment in the region. Service-rendering industries comprise 71 percent of all jobs, including public sector positions. In other words, 932,713 jobs out of a total of 1,317,365 jobs are in service-rendering industries. Excluding the public sector, service-rendering jobs account for 52 percent of all jobs in 2008. In 2003, service-rendering industries (excluding the public sector) represented 51 percent of all jobs, indicating that the transition toward a services economy was in place as early as the mid to late 1990s with the significant increase in the number of people during that time.

Employment increases in service-rendering industries are consistent with regional population growth. In the region, local support industries of local and private education, and health, and financial activities increased annually by 3.9 percent, 3.0 percent, and 2.7 percent respectively between 2003 and 2008.

Construction and financial services are two other local support industries that grew in accordance with the region's population   surge; however, with the downturn in the

national economy, these industries' rates of growth have lowered dramatically. Employment in construction grew by a 6.7 percent per year in the five-year period stretching from 1998 to 2003. Between 2003 and 2008, construction continued to grow but by a slower rate of 0.9 percent per year. Likewise for financial services, which grew annually by 3.9 percent between 1998 and 2003, and has since grown by a slight 0.9 percent per year.

Close examination of Table 2 shows that the region experienced modest growth in manufacturing, as employment in this sector grew annually by 0.9 percent between 2003 and 2008. This modest increase reversed substantial declines experienced between 1998 and 2003, when manufacturing employment dropped annually by 0.6 percent. What was a regional bright spot between 1998 and 2003 (2.7 percent per year), transportation and warehousing declined annually by 1.1 percent between 2003 and 2008, as compared to the 2.7 percent annual growth in the previous five-year period.

TABLE 2
ECONOMIC TRENDS: SAN JOAQUIN VALLEY, 1998-2008

	NAICS	1998 Estab.	1998 Employment	1998 Average Pay	2003 Estab.	2003 Employment	2003 Average Pay	2008 Estab.	2008 Employment	2008 Average Pay	Employment Distribution 2008 Region	Employment Distribution 2008 California	Employment: Annual Percent Change 98-03	Employment: Annual Percent Change 03-08
ALL		**80,398**	**1,060,454**	**$33,566**	**92,231**	**1,209,849**	**$40,577**	**100,414**	**1,317,365**	**$39,543**	**100.0%**	**100.0%**	**2.7%**	**1.7%**
Ag, Natural Resources	11	7,580	139,953	$18,285	8,646	169,556	$23,354	7,371	178,522	$21,714	13.6%	2.5%	3.9%	1.0%
Utilities	21	251	9,533	$66,831	213	8,340	$81,309	185	10,512	$82,627	0.8%	0.0%	-2.6%	4.7%
Mining	22	165	4,231	$72,458	179	5,071	$86,065	169	5,618	$81,296	0.4%	0.4%	3.7%	2.1%
Construction	23	6,124	49,851	$38,969	6,074	69,065	$46,870	6,705	72,312	$44,716	5.5%	5.7%	6.7%	0.9%
Manufacturing	31-33	2,998	113,344	$40,989	2,779	110,002	$48,735	2,662	115,153	$43,352	8.7%	9.3%	-0.6%	0.9%
Wholesale	42	2,749	33,365	$47,726	2,722	37,124	$53,053	3,027	45,299	$46,510	3.4%	4.6%	2.2%	4.1%
Retail	44-45	9,586	121,132	$26,446	8,941	132,956	$31,349	8,882	143,910	$25,892	10.9%	10.8%	1.9%	1.6%
Transport Warehousing	48-49	2,306	33,821	$38,946	2,237	38,554	$44,962	1,957	36,514	$40,166	2.8%	2.7%	2.7%	-1.1%
Information	51	653	14,885	$43,401	692	14,257	$53,695	625	15,328	$47,417	1.2%	3.0%	-0.9%	1.5%
Finance and Insurance	52	2,637	27,792	$46,709	3,046	30,690	$59,530	3,373	32,027	$50,112	2.4%	4.0%	2.0%	0.9%
Real Estate	53	2,575	13,180	$26,755	2,607	15,932	$34,144	2,784	15,897	$32,633	1.2%	1.8%	3.9%	0.0%
Prof Technical Services	54	4,064	25,130	$44,216	4,501	31,812	$52,467	4,839	36,411	$46,773	2.8%	6.8%	4.8%	2.7%
Management of Companies	55	321	17,997	$52,338	316	13,988	$60,045	288	10,551	$55,323	0.8%	1.3%	-4.9%	-5.5%
Admin and Waste Services	56	2,910	44,283	$22,362	2,768	48,182	$28,986	2,947	58,761	$27,165	4.5%	6.4%	1.7%	4.0%
Private Educational Services	61	459	7,107	$25,456	480	9,298	$29,532	497	10,781	$27,407	0.8%	1.7%	5.5%	3.0%
Health Services	62	6,082	90,304	$38,243	6,526	110,647	$47,867	6,983	126,598	$44,058	9.6%	8.8%	4.1%	2.7%
Arts, Entertainment, Rec.	71	617	10,386	$16,985	621	10,244	$20,192	641	11,172	$17,305	0.8%	1.6%	-0.3%	1.7%
Food and Accommodations	72	5,050	70,335	$12,860	4,942	78,805	$15,831	5,312	90,404	$14,020	6.9%	8.3%	2.3%	2.8%
Other Services	81	20,157	41,069	$21,165	30,390	47,370	$25,731	35,629	52,505	$21,606	4.0%	4.6%	2.9%	2.1%
Unclassified	99				85	199	$38,033	1,769	2,534	$26,836	0.2%	0.3%		
Local Govt., excl Education		409	51,325	$45,674	437	60,768	$56,307	477	68,469	$51,051	5.2%	5.2%	3.4%	2.4%
Local Govt., Education		881	90,200	$39,664	1,487	109,087	$48,304	1,792	118,716	$78,718	9.0%	5.9%	3.9%	1.7%
State, ALL		1,464	23,639	$46,051	1,166	28,463	$56,515	1,078	31,639	$51,222	2.4%	2.9%	3.8%	2.1%
Federal, ALL		360	27,592	$52,749	376	29,439	$66,395	424	27,732	$58,945	2.1%	1.6%	1.3%	-1.2%

Source: ADE, Inc., based on California Employment Development Department, LMID

3.3 DESCRIPTION OF AFFECTED INDUSTRIES

Whereas the previous section described the larger economic context within which the District is contemplating proposed new Draft Rule 4695, this section analyzes industries directly affected by the proposed rule. This rule affects wineries and brandy aging facilities operating in the eight county region. As the table below shows, there are 78 wineries/brandy aging facilities in the San Joaquin Valley region. These establishments employ an estimated 5,161 workers. Between 2004 and 2008, the number of wineries/brandy aging facilities increased by 11, with the number of workers also increasing by 359, for an annual employment growth rate of 1.8 percent per year. In the state as a whole, employment growth more than doubled that of the San Joaquin Valley region, as winery employment grew by 3.8 percent per year in California between 2004 and 2008. While employment grew faster across the state, wineries in the Central Valley tend to be larger than those in the state as a whole, at 66 workers per winery versus the state average of 25 workers per winery.

TABLE 3
ECONOMIC TRENDS: INDUSTRIES POTENTIAL SUBJECT TO PROPOSED DRAFT NEW RULE 4695: 1994-2008: WINERIES AND BRANDY AGING FACILITIES

REGION	2004	2005	2006	2007	2008	04-08 Change	CAGR
Establishments	67	66	67	68	78	11	3.87%
Employment	4,802	4,998	5,037	4,951	5,161	359	1.82%
STATE							
Establishments	850	892	976	1042	1102	252	6.71%
Employment	24,047	25,218	26,317	26,716	27,900	3,853	3.79%

Source: Applied Development Economics, Inc., based on California EDD LMID

The 78 wineries/brandy aging facilities in the region generate an estimated $2.6 billion in revenues. This figure is based on data from the US Economic Census of 2002, which was then adjusted for inflation and converted into a revenue per worker ratio, which was further adjusted to account for changes in the number of workers between 2002 and 2008.

TABLE 4
ECONOMIC PROFILE OF WINERIES IN SAN JOAQUIN VALLEY REGION, 2008

Establishments	78
Employment	5,161
Revenues Est.	$2,596,538,232

Source: ADE, Inc., based on EDD LMID and US Census

SECTION 4. SOCIOECONOMIC IMPACTS ANALYSIS

This section of the report compares the economic characteristics of affected industries against annual compliance costs associated with the proposed draft rule. We begin with a review of compliance cost estimates generated by the San Joaquin Valley Unified Pollution Control District.

4.1 ANNUAL COMPLIANCE COST ESTIMATES

District staff analyzed seven control measures that affected sources might employ when seeking to comply by proposed Draft New Rule 4695. For a detailed discussion on these control measures, see District staff report called "Appendix C: Cost Effectiveness Analysis for Draft New Rule 4695" (April, 2009). The measures are listed below in the table below, which includes total annual costs of each measure. It is important to note that only one wine-aging and one brandy-aging are right now out of compliance with proposed Draft New Rule 4695, in the event this rule is adopted.

TABLE 5
ANNUAL COMPLIANCE COST SCENARIOS PER VARIOUS CONTROL MEASURES:
DISTRICT COST SCENARIO

	Brandy Aging Facility Cost Scenarios	Wine Aging Facility Cost Scenarios
Thermal oxidation with 50% heat recovery (low capital/high fuel cost)	$82,000	$232,300
Catalytic oxidation with 50% heat recovery (mid range capital/mid range fuel cost)	$83,234	$197,100
Regenerative thermal oxidation with 95% heat recovery (high capital/low fuel cost)		$172,600
Water scrubber	$276,800	$579,100
Biofilter	$83,700	$188,300
Carbon adsorption	$156,100	$251,000
Refrigerated Condenser	$83,400	$172,800

Source: San Joaquin Valley Unified Air Pollution Control District

In June, 2009, stakeholders directly affected by the proposed draft new rule shared what they believe to be total costs of the new rule. Combined, these entities will bear $3,466,245 in total costs, or $843,207 when total costs are annualized using a factor of 0.162745.

4.2 BUSINESS RESPONSES

Industries impacted by the draft rule may respond in a variety of ways when faced with new regulatory costs. These responses may range from simply absorbing the costs and accepting a lower rate of return, to shutting down the affected business operation altogether and, where practical, shift from lower-value to higher-value product. Affected sources may also seek to renew efforts to increase productivity and reduce costs elsewhere in their operation in order to recoup the regulatory costs and maintain profit levels.

It is important to note that wineries in the San Joaquin Valley region tend to market to lower to middle segments of the wine and brandy markets, where price is a significant factor when it comes to purchasing. Thus, sources impacted by proposed Draft New Rule 4695 may experience some difficulty in passing to consumers costs stemming from the proposed rule. Consumers might decide to purchase less expensive wines from other parts of the state, nation, and world.

4.3 SOCIOECONOMIC IMPACT ANALYSIS

This section of the report analyzes estimated after tax net profits of affected industries against anticipated costs associated with implementation of proposed Draft New Rule 4695. While there are 78 wineries and brandy aging facilities operating in the San Joaquin Valley region per the California EDD, only two facilities operated will be impacted by the proposed new rule. These facilities are owned by two major, global corporations. As indicated in the table below, these entities annually generate an estimated $1.6 billion in revenues, off of which is generated an estimated $109.9 million in net profits.[1]

TABLE 6
REVENUE AND NET PROFITS OF ENTITIES AFFECTED BY PROPOSED NEW DRAFT RULE 4695

	Revenues	Est. Net Profits
Entities (2) Impacted By Proposed Draft New Rule	$1,570,735,484	$109,982,972

Source: ADE, Inc., based on CA EDD (establishments and employment and aggregate payroll), Forbes, Mondavi SEC 10-K corporate annual report 2004, Wine Business Monthly, US Census (employment, wages, shipment value), Dun and Bradstreet, US IRS, Almanac of Business and Financial Ratios/CCH, and Gale Group

Table 7 below analyzes socioeconomic impacts with regard to cost data generated by the District, whereas Table 8 analyzes cost data produced by two impacted stakeholders. As the tables below show, entities are not significantly impacted by the proposed draft new rule, as costs-to-net profit ratios are less than significant for the most part, with one exception in Table 7. Table 8 shows that, per annual costs produced by affected industry stakeholders, costs are less than significant.

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[1]Net profit is based on an after-tax net profit rate for wineries generating more than $250 million in revenues per year. The after-tax net profit rate is a ten-year average (1994-2004), which was calculated so as to balance years of high profitability and years of low/no profitability (Source: Troy, Leo, Almanac of Business and Industrial Financial Ratios [CCH, Inc., Chicago, IL])

TABLE 7
SOCIOECONOMIC IMPACT ANALYSIS OF PROPOSED DRAFT
NEW RULE 4695: DISTRICT COST SCENARIO

	Wine Aging Facilities Total Annual Cost	Adjusted Wine Aging Facilities Total Annual Cost: (Adjustment Factor: 13/9)	Cost as Percent of Net Profits	Significant	Brandy Aging Facilities Total Annual Cost	Adjusted Brandy Aging Facilities Total Annual Cost: (Adjustment Factor: 47/5)	Cost as Percent of Net Profits	Significant
Thermal Ox	$232,300	$335,544	1.65%	no	$82,000	$770,800	0.9%	no
Cat OX	$197,100	$284,700	1.40%	no	$83,234	$782,400	0.9%	no
RTO	$172,600	$249,311	1.22%	no				
Scrubber	$579,100	$836,478	4.11%	no	$276,800	$2,601,920	2.9%	no
Biofilter	$188,300	$271,989	1.34%	no	$83,700	$786,780	0.9%	no
Carbon	$251,000	$362,556	1.78%	no	$156,100	$1,467,340	1.6%	no
Refrigeration	$172,800	$249,600	1.23%	no	$83,400	$783,960	0.9%	no

Source: ADE, Inc.

TABLE 8
SOCIOECONOMIC IMPACT ANALYSIS OF PROPOSED DRAFT
NEW RULE 4695: IMPACTED STAKEHOLDER COST SCENARIO

	Impacted Wine/Brandy Aging Facilities Total Annual Cost	Cost as Percent of Net Profits	Significant
RTO	$843,207	0.8%	No

Source: ADE, Inc.

4.4 SMALL BUSINESS DISPROPORTIONATE IMPACT ANALYSIS

In addition to analyzing the employment impacts of proposed New Draft Rule 4695, state legislation requires that the socioeconomic analysis assess whether small businesses are disproportionately affected by air quality rules. This section begins by briefly summarizing how the state government defines small businesses for the purposes of qualifying certain businesses for various programs. This section concludes with a discussion as to whether the affected industries include small businesses and assesses whether those small businesses are disproportionately impacted by the new rules.

DEFINITION OF A SMALL BUSINESS

For purposes of qualifying small businesses for bid preferences on state contracts and other benefits, the State of California defines small businesses in the following manner[2]. To be eligible for small business certification, a business:

- Must be independently owned and operated;

- Cannot be dominant in its field of operation;

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[2] State of California. Department of General Services. "California Small Business Certification" (http://www.pd.dgs.ca.gov/smbus/sbcert.htm)

- Must have its principal office located in California

- Must have its owners (or officers in the case of a corporation) domiciled in California; and

- Together with its affiliates, be either:

  - A business with 100 or fewer employees, and an average gross receipts of $10 million or less over the previous tax years, or

  - A manufacturer with 100 or fewer employees

The proposed draft rule affects two large, global corporations, which for the most part do not fall within the definition of a small business. Thus, proposed Draft Rule 4695 does not disproportionately impact small businesses.

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APPENDIX E

RULE CONSISTENCY ANALYSIS
FOR
PROPOSED RULE 4695

September 17, 2009

APPENDIX E
Rule Consistency Analysis

I.   REQUIREMENTS OF ANALYSIS

Pursuant to Section 40727.2 of the California Health and Safety Code, prior to adopting, amending, or repealing a rule or regulation, the District is required to perform a written analysis that identifies and compares the air pollution control elements of the rule or regulation with corresponding elements of existing or proposed District and United States Environmental Protection Agency (EPA) rules, regulations, and guidelines that apply to the same source category. The elements that were analyzed are emission standards, monitoring and testing, and recordkeeping and reporting requirements.

II.   RULE CONSISTENCY ANALYSIS

A.   District Rules

Facilities could be subject to other District rules including:

- Rule 1040 (Enforcement)
- Rule 1070 (Inspections)
- Rule 1081 (Source Sampling)
- Rule 1090 (Penalty)
- Rule 1100 (Equipment Breakdown)
- Rule 1140 (Applicability of Emission Limits)
- Rule 2010 (Permits Required)
- Rule 2020 (Exemptions)
- Rule 2040 (Application)
- Rule 2050 (Cancellation of Application)
- Rule 2070 (Standards for Granting Application)
- Rule 2080 (Conditional Approval)
- Rule 2092 (Standards for Permits to Operate)
- Rule 2201 (New and Modified Stationary Source Review Rule)
- Rule 3010 (Permit Fee)
- Rule 3020 (Permit Fee Schedule)
- Rule 3100 (California Environmental Quality Act Fee)
- Rule 3170 (Federally Mandated Ozone Nonattainment Fee)
- Rule 4001 (New Source Performance Standards)
- Rule 4002 (National Emission Standards for Hazardous Air Pollutants)
- Rule 4102 (Nuisance)
- Rule 4694 (Wine Fermentation and Storage Tanks)

The above-listed rules are not in conflict with, nor are they inconsistent with the requirements of Proposed Rule 4695.

B.   Federal EPA Rules and Regulations

1.   *Best Available Control Technology (BACT)*

There is no EPA BACT for Brandy Aging and Wine Aging.

2.   *Reasonably Available Control Technology (RACT)*

There is no EPA RACT for Brandy Aging and Wine Aging.

3.   *Lowest Achievable Emission Rate (LAER)*

There is no EPA LAER for Brandy Aging and Wine Aging.

4.   *New Source Performance Standards (NSPS)*

There is no EPA NSPS for Brandy Aging and Wine Aging.

5.   *National Emission Standards for Hazardous Air Pollutants (NESHAPs)*

There is no EPA NESHAP for Brandy Aging and wine Aging.

6.   *Maximum Achievable Control Technology (MACT)*

There is no EPA MACT for Brandy Aging and Wine Aging.

7.   *Federal Control Techniques Guideline (CTG)*

There is no EPA CTG for Brandy Aging and Wine Aging.

8.   *Alternative Control Technology (ACT)*

There is no EPA ACT for Brandy Aging and Wine Aging.

7. *EPA Policy on Recordkeeping*

The recordkeeping requirement in Rule 4311 is consistent with EPA's policy to keep and maintain records for at least five years.

III. CONCLUSION

Based on the above analysis, District staff concludes that none of the proposed requirements of Proposed Rule 4695 would conflict with federal rules, regulations, or policies covering similar stationary sources.

BEFORE THE ENVIRONMENTAL PROTECTION AGENCY

Petition for the Exemption
of Beverage Alcohol from Regulation
As a Precursor to Tropospheric Ozone
Under the Clean Air Act

DISTILLED SPIRITS COUNCIL OF THE UNITED STATES, INC.
1250 Eye Street, N.W.
Suite 900
Washington, D.C. 20005-3998

OF COUNSEL:

Leslie S. Ritts
Chadbourne & Parke
1101 Vermont Avenue, N.W.
Washington, D.C. 20005

December 9, 1992

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December 9, 1992

HAND DELIVERED

The Honorable William K. Reilly
Administrator
United States Environmental
  Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

> Re: Petition to Exclude Beverage Alcohol from
>   Definition of Volatile Organic Compound
>   Pursuant to the Clean Air Act

Dear Administrator Reilly:

The Distilled Spirits Council of the United States,
Inc. ("DISCUS"), a national trade association representing
the producers of over 80% of the distilled spirits[1] sold in

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1. "Distilled spirits" include whisky, Bourbon, vodka, gin,
brandy, tequila and rum. The term is defined in the Federal
Alcohol Administration Act as "ethyl alcohol, hydrated oxide
of ethyl, spirits of wine, whiskey, rum, brandy, gin, and
other distilled spirits, including all dilutions and mixtures
thereof, for non-industrial use." 27 U.S.C. § 211 (1992).
The Bureau of Alcohol, Tobacco and Firearms defines
"distilled spirits" as "[t]hat substance known as ethyl
alcohol, ethanol or spirits of wine in any form. . . ." 27
C.F.R. § 19.11.

the United States, requests EPA to exercise its authority
under § 302(s) of the Clean Air Act and 40 C.F.R.
§ 51.100(s), to grant this petition to exclude beverage
alcohol[2] from EPA's definition of volatile organic
compound.[3] EPA previously has determined that beverage
alcohol should be exempted from various Clean Air Act
regulations for the control of VOC emissions.[4] As EPA has
recognized, such regulation potentially could have crippled
the beverage alcohol industry while providing no significant
environmental quality benefit.

        Concern regarding potential new regulation of
beverage alcohol as a VOC compels EPA to examine the
reactivity of beverage alcohol and the absence of benefit

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2.   "Beverage alcohol" is a complex mixture of compounds
including ethanol, congeners, and water. Beverage alcohol is
produced from the fermentation of cereal grains, fruits,
potatoes, molasses, wine or other agricultural products; on
this basis, it is distinguishable from synthetic alcohols
produced from petrochemical feedstocks such as ethylene and
natural gas (D.J. McWeeny and M.L. Bates, Discrimination
Between Synthetic and Natural Ethyl Alcohol in Spirits and
Fortified Wines, 15 J. Food Technology 407-412 (1980)); see
also EPA's Draft EIS to the proposed NSPS for SOCMI Reactor
Processes (450/3-90-016a - June 1990) which clearly
distinguished both the production and end use of beverage
alcohols from synthetic alcohols. It also is distinguishable
from ethanol produced for oxygenated fuels because of the
presence of substances other than ethanol including esters
acquired during the fermentation and aging processes and
because it is regulated as a "food" by the Federal Food, Drug
and Cosmetic Act pursuant to 21 U.S.C. § 301 et seq.

3.   The Clean Air Act defines "VOC" as "volatile organic
compound, as defined by the Administrator." 42 U.S.C.
§ 7602(s). EPA has defined VOC first through a series of
policy statements and later codified in a rulemaking as, "any
compound of carbon . . . which participates in atmospheric
photochemical reactions. This includes any such organic
compound other than the [exempted compounds] which have been
determined to have negligible photochemical reactivity." 40
C.F.R. § 51.100(s); 57 Fed. Reg. 3941, 3945 (February 3,
1992).

4.   These rulemakings, largely relevant to pollution
controls applicable to the synthetic organic chemical
manufacturing industry, are discussed below.

toward achievement of the nation's ozone standard that its
control would provide. The Clean Air Act Amendments of 1990
("CAAA"), and federal guidance to states,[5] provide that
states must implement § 181 et seq. of the Clean Air Act by
(1) including all VOC emissions sources in an improved state
emissions inventory; (2) imposing reasonably available
control technology ("RACT") on all "major sources" of VOCs;
and (3) requiring through implementation of the operating
permit regulation (codified at 40 C.F.R. Part 70) that such
sources in both attainment and nonattainment areas obtain
federal operating permits. Despite these significant
regulatory developments, nothing has changed in the way
distilled spirits are produced by this industry to alter
EPA's historic conclusions regarding the absence of any
significant environmental quality benefit of regulating
beverage alcohol emissions or the feasibility of applying
controls to this industry. The present potential for such
regulation imperils this industry's future at a particularly
critical economic point in its history.

EPA's long-standing policies on photochemically
reactive compounds, now codified in a general definition at
40 C.F.R. 51.100(s), 57 Fed. Reg. 3941, 3943 (Feb. 3, 1992),
allow the Agency to exclude from the definition of "VOC,"
compounds which do not significantly contribute to
tropospheric ozone formation. See 42 Fed. Reg. 35,314 (July
8, 1977); 44 Fed. Reg. 32,942 (June 4, 1979); 45 Fed. Reg.
32,424 (May 16, 1980); 45 Fed. Reg. 48,941 (July 22, 1980);
54 Fed. Reg. 1987 (Jan. 18, 1989); 56 Fed. Reg. 11,418 (Mar.
18, 1991). As is explained in detail below, under commonly
accepted theories of atmospherics chemistry such as
"incremental reactivity," emissions of ethanol into the
ambient air from the distillation and aging of beverage
alcohol do not have the potential to significantly contribute
to the atmospheric formation of ozone. Further, such
understanding of the atmospheric kinetics of ozone formation
is implicit in § 182(b)-(e) of the Clean Air Act and in EPA's
atmospheric dispersion models.

The remainder of this petition provides detailed
discussion regarding the ozone forming potential of beverage
alcohol; prior EPA Clean Air Act rulemakings that could have
potentially devastated the U.S. distilled spirits industry
had emissions from beverage alcohol facilities not been
exempted; EPA's own findings with respect to the absence of

_____

5.   See General Preamble for Title I of the Clean Air Act
Amendments, 57 Fed. Reg. 13,498 (April 16, 1992), as amended.

reasonably available control technology for controlling
emissions from the production of distilled spirits; and other
national policy considerations.

Finally, the petition includes a description of the
federal oversight and regulation of the distilled spirits
industry by the Federal Bureau of Alcohol, Tobacco and
Firearms, and the Internal Revenue Service.   In this respect,
the distilled spirits industry differs from any other
industry that will be regulated by EPA under the Clean Air
Act.   Because beverage alcohol losses are closely monitored
and can be heavily taxed (currently at $13.50 per proof
gallon of alcohol lost) in a federal "cradle-to-grave" scheme
that covers the manufacturing, bottling and distribution
process, EPA should be assured, that in exempting beverage
alcohol from Clean Air Act regulations, an existing federal
scheme remains in place to monitor closely this industry's
performance.   Further, the distillers themselves have a
strong financial incentive to minimize losses in order to
maximize marketable product.

I.   BACKGROUND

A.   Producing Beverage Alcohol

Ethanol is emitted into the air from beverage
alcohol production facilities, as a result of techniques
utilized by distillers since the thirteenth or fourteenth
century to age[6] raw alcohol into the distinctive products
sold in the United States and abroad.   EPA and its
contractors have recognized that other processes in the
production of beverage alcohol -- fermentation, distillation
and drying of used grain -- are far less significant sources
of emissions into the air.[7]

In the aging process, both the oak barrel in which
beverage alcohol is stored and the barrel environment are key

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6.   Many distilled spirits, including Bourbon whisky, other
whiskies, Scotch, rum, cognac, and brandy, are aged.

7.   "The production of unaged whiskey is a source of only a
small percent of the volatile organic chemicals emitted in
whiskey manufacture."   EPA Cost and Engineering Study -
Control of Volatile Organic Emissions from Whiskey
Warehousing, p. 2 Appendix A-1 (EPA-450/2-78-013; April
1978).   See also supra note 13 and accompanying text.

to producing distilled spirits of desired quality and
uniqueness. The maturation process gives whisky its
characteristic color and distinctive flavor and aroma.
Variations in the aging process are integral to producing the
characteristic tastes and blends of different products and
brands.

Ambient atmospheric conditions, such as temperature
and humidity, as well as seasonal variation, are important
factors in the aging process.[8] As EPA observed in its 1978
Cost and Engineering Study of the Distilled Spirits Industry,
the aging process in particular depends upon the interaction
of oak barrels with ambient air and particularly the
temperature, humidity, and ventilation promoted by the
different types of warehouse construction utilized in the
industry. While each distiller alters the barrel environment
to produce a product with the distinctive characteristics of
their brand, the fundamentals of the natural aging process
are inviolate.

In producing Bourbon whisky, for example, ethanol
from the raw beverage alcohol is unavoidably released because
wooden barrels in which it is aged are housed in special open
air warehouses for periods of two to eight years or more.[9]
When whisky ages, the alcohol absorbs and reacts with
constituents in the barrel wood, producing its distinctive
color, taste and aroma. Materials in the wood are
transferred to the bulk liquid in the barrel by simple
diffusion, by convection currents in the bulk liquid and by
temperature cycling. As the barrel heats up, the gas above
the liquid increases in pressure and forces liquid into the
barrel wood. When the barrel cools and the gas pressure
drops, the liquid flows out of the wood into the bulk liquid,
carrying wood constituents with it. The distinctive
qualities of whisky are added during aging as trace
substances called congeners which occur through 1) extraction
of organic substances from the wood and their transfer to the
whisky, 2) oxidation of the original substances and of the
extracted wood material, and 3) reaction between various

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8.   Aging practices vary considerably -- some distillers,
for example, keep their warehouse windows open during certain
months to promote interaction of the barrel with outdoor
atmospheric conditions.

9.   The use of oak barrels for aging is not only an
industry-wide practice, but also is required by federal
regulation for the production of whisky. See, 27 CFR § 5.22.

organic substances present in the liquid to form new products. The amber color develops and the taste of the whisky mellows during aging as the concentration of congeners increases. Ethyl alcohol emissions are a natural and integral consequence of creating the distinctive qualities of Bourbon, production and aging of which is embodied in the federal law. Very similar reactions between the barrel liquid and barrel constituents characterize aging of other distilled spirits such as brandy, rum, Scotch, and cognac.

In aging or maturation, the rate of extraction of wood constituents, transfer, and reaction depend on both ambient conditions such as temperature and humidity and the concentrations of various whisky constituents. For instance, higher temperatures increase the rate of extraction, transfer by diffusion, and reaction. Diurnal and seasonal temperature changes also cause convection currents in the liquid and pressure changes in the gas affecting transfer. The rate of diffusion will depend upon the difference of concentrations of constituents in the wood, liquid, and air blanketing the barrel. The rates of reaction will increase or decrease with the concentration of constituents. The equilibrium concentrations of the various whisky components depend heavily upon the air flow around the barrel. All of these variables are utilized by a distiller to produce a particular product brand which will have its own unique taste, color, and aroma. In fact, EPA has acknowledged in its 1978 Cost and Engineering Study of the industry that, when buildings are closed and ventilation is artificially increased, for instance, the quality of the product was greatly impaired.

During the aging period, and particularly during the first two years, beverage alcohol and water soak into the barrel and evaporate into the air. Ethanol from beverage alcohol also is potentially released into the air in very small amounts when the barrels are emptied to bottle the product, and, in some operations, when a portion of the ethanol and water remaining in the barrel after it is emptied evaporate into the air. The degree of these losses, which are very small, frequently are a function of how quickly a barrel is put back into service by the distiller.[10]

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10. In keeping with federal regulations and because of constituents of the barrel imparted to Bourbon in the aging process, only new oak barrels can be used in Bourbon production. Barrels are frequently reused for other whiskies

B.   Historic Exemption of Beverage Alcohol from
      Regulation under the Clean Air Act

      1.   Standards of Performance for New Stationary
            Sources

            EPA consistently has excluded the production of
beverage alcohol from regulation under the Clean Air Act. In
doing so, the Agency has recognized that the control and
release of the alcohol plays an integral part in the natural
fermentation of grains, distillation, and aging processes
unique to the production of beverage alcohol. It also has
recognized that, while best demonstrated technology exists
for the synthetic production of ethanol from fossil fuels, no
comparable pollution control equipment has been demonstrated
for the production of beverage alcohol from cereal grains.[11]

            To date, EPA has exempted expressly producers of
beverage alcohol from the following federally applicable air
pollution control requirements under the New Source
Performance Standards ("NSPS"):

      (1)   In the final list of 59 major source
            categories for which standards of
            performance for new stationary sources
            would be promulgated pursuant to the Clean
            Air Act Amendments of 1977, whisky
            manufacturing was expressly deleted from
            the list. The rule stated that "whiskey
            manufacture was deleted due to a lack of
            any demonstrated control technology." 44
            Fed. Reg. 49,222, 49,224 (Aug. 21, 1979).

      (2)   The final standards of performance for
            equipment leaks of VOC in new or modified
            SOCMI process units, also excluded beverage
            alcohol, finding "production of beverage
            alcohol for human consumption [is] not

(Cont'd from preceding page)

and other distilled spirits products such as cognacs, Scotch
and brandies. Although the practice of allowing barrels to
dry in open air areas following bottling is described in
EPA's 1978 Cost and Engineering Study, this practice varies
in the industry.

11.   See e.g., 44 Fed. Reg. 49,222, 49,224 (Aug. 21, 1979).

within the scope of the SOCMI source
category." 48 Fed. Reg. 48,328, 48,336
(Oct. 18, 1983).

(3) Final standards of performance for volatile
organic liquid storage vessels excluded
beverage alcohol from the rule. The notice
of final rulemaking stated that "the
proposed control technologies required by
these standards could contaminate beverage
alcohol resulting in a product with little
or no market value." 52 Fed. Reg. 11,420,
11,424 (Apr. 8, 1987).

(4) The final standards of performance for
process emissions of VOC in new or modified
SOCMI distillation facilities also exclude
distillation units that produce beverage
alcohol. 55 Fed. Reg. 26,931, 26,942 (June
29, 1990).[12]

Excluding beverage alcohol from the definition of a
VOC would be consistent with EPA's policy of exempting
beverage alcohol facilities under its NSPS program. Despite
the technology focus of the NSPS program, its goals also are
clearly driven by achievement of the National Ambient Air
Quality Standards.

2. EPA Also Previously Determined that It Is
Technically Infeasible to Impose Controls on
Existing Whisky Warehouses.

The Agency conducted studies of the beverage
alcohol industry in 1976 and 1977 in which DISCUS actively
cooperated. In 1978, EPA published "Cost and Engineering

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12. DISCUS also has requested clarification that this
industry's facilities are not within the scope of the
proposed NSPS for "SOCMI" reactor facilities proposed on June
29, 1990 (55 Fed. Reg. 26,953), which reportedly is nearing
finalization by the end of the year. See comments filed by
DISCUS on September 12, 1990 in Docket No. A-83-29.
Significantly, the draft Environmental Impact Statement for
the SOCMI Reactor NSPS takes great care to distinguish
between synthetic alcohols produced from petroleum feedstocks
and alcohols produced through natural fermentation processes.

Study - Control of Volatile Organic Emissions from Whiskey
Warehousing" (EPA-450/2-78-013) ("EPA Study"). This document
is based in part on a contractor study entitled, "Emissions
and Control Technology of the Aging Process in the Whiskey
Distilling Industry," PEDCo Environmental, Inc. (June 1977)
("PEDCo Study"). In its Cost and Engineering Study, EPA
focused only on emissions from whisky warehouses.
Recognizing that alcohol evaporation as a result of the
fermentation and distillation process is too small a factor
to justify regulation, EPA stated, "the production of unaged
whiskey is a source of only a small percent of the volatile
organic chemicals emitted in whiskey manufacture."[13]   See
EPA Study, p. 2-1. Nothing has changed in distillers'
production of distilled spirits since the mid-1970s that
would affect the findings in the Agency's studies.

       EPA identified carbon adsorption systems
("CA system") as a possible type of pollution control for
warehouses in its 1978 Cost and Engineering Study but
concluded that "whiskey quality could be affected if the
carbon adsorption system altered such warehouse conditions as
temperature, humidity and ventilation." Id. at p. 1-3; see
also id. at pp. 4-8, 4-16. The report continued that while a
carbon adsorption unit might be designed with straightforward
engineering and at a moderate cost,

           the proper design is not the only criterion; it
           is important to know what conditions to
           reproduce. Given the complex nature of whiskey
           aging, it is difficult to state precisely what
           are the conditions for proper aging and thus how
           to design the CA system. This is especially
           true considering the number of different brands
           of whiskey. Development of the system through
           experimentation is also difficult. . . . Thus,
           the CA system's effect on whiskey quality is
           indeterminate. It would appear possible to
           design a system to reproduce the desired
           conditions but not possible to state with

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13. Likewise, the PEDCo report also concluded that fugitive
ethanol emissions from production were extremely low. "The
maturation or aging process . . . is by far the largest
atmospheric organic area of emission in the whiskey
distilling industry." PEDCo, p. 1-1. See also id. at 6-1.

precision what these conditions are. <u>Id</u>. at pp. 4-9, 4-10.[14]

In both its 1978 Cost and Engineering Study and again in its consideration of technology for NSPS storage vessels, EPA concluded that available emission control technology "could contaminate beverage alcohol resulting in a product with little or no market value." 52 Fed. Reg. 11,420, 11,424 (Apr. 8, 1987).

As discussed above, the complex process involved in producing a unique distilled spirits product is dependent upon the aging process and upon the temperature, humidity, and ventilation of the warehouse in which the product is aged. The alteration of any of these factors to control the emission of ethanol, would alter the distinctive taste, aroma, and color of the final product. Therefore, in order to control the emission of the VOCs from the production of spirits, EPA would be required to regulate the barrels and/or the aging process, since these are the most significant sources of ethanol into the air. Any such control would destroy the quality and palatability of the product. In fact, EPA recognized that any such controls would require major changes in aging practices that are inherent in producing a particular distilled spirits brand, which inevitably would result in a changed product. Brands would lose their distinctive character and all would be altered.

II. <u>REACTIVITY OF BEVERAGE ALCOHOL</u>

A.   <u>EPA's Definition of VOC</u>

While ethanol meets EPA's current regulatory definition of a VOC because it has not been expressly excluded, ethanol contributes far less photochemical oxidizing capacity to the atmosphere than other hydrocarbons emitted into the environment in high volumes, such as hydrocarbons from automobile fuels or the synthetic chemical industry. EPA's definition of VOC and its former VOC reactivity policy,[15] recognize that some VOCs have such low

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14. Although EPA concluded in 1978 that enclosing the warehouse may not violate OSHA standards, the study does not address possible fire hazards in a closed building or safety considerations which encourage minimizing explosiveness of mixtures of ethyl alcohol and air.

15. 57 Fed. Reg. 3,941 (February 3, 1992) (codifying EPA's reactivity policy statements).

photochemical reactivity or react so slowly in the
atmosphere, that they can be ignored in states' photochemical
oxidant ("ozone") control programs.[16] On the basis of
these atmospheric kinetics, EPA has identified a list of
volatile organic compounds of negligible photochemical
reactivity that should be exempt from regulation under state
implementation plans. The Agency stated in its initial 1977
policy that such compounds "should not be included in the
baseline [emissions inventory] nor should reductions in their
emissions be credited toward achievement of the NAAQS." 42
Fed. Reg. 35,314. In the preamble to EPA's codified rule,
the Agency reiterated, "the Agency will not approve or
enforce measures controlling substances EPA has determined to
be negligibly reactive as part of a federally-approved ozone
SIP." 57 Fed. Reg. 3,941, 3,944.

          This petition submits that EPA should exercise its
authority under the Clean Air Act to determine that ethanol
from beverage alcohol does not significantly contribute to
the nation's ozone problems. This petition also submits that
EPA's policies concerning VOC reactivity and the general
definition of VOC allow the Agency to incorporate commonly
accepted theories of atmospheric chemistry, such as
incremental reactivity. In fact, Section 181 et seq. of
Title I of the CAAA acknowledge that ozone formation results
from the complex interactions of nitrogen oxides and VOCs in
the atmosphere. As a result, the Act regulates both classes
of compounds in nonattainment areas as ozone precursors.[17]
Moreover, the National Research Council of the National
Academy of Sciences has recommended a fundamental shift in

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16. Section 110 of the Clean Air Act, 42 U.S.C. § 7410,
requires each state to develop and submit to EPA a State
Implementation Plan ("SIP") designed to achieve and maintain
the national ambient air quality standards ("NAAQS") for each
criteria pollutant established by EPA. Under Section 110 of
the Clean Air Act, SIPs must be developed to achieve and
maintain the ozone NAAQS, through the administration,
implementation and enforcement of air pollution requirements
applicable to VOCs and other pollutants. See General
Preamble for Title I of the Clean Air Act Amendments of 1990,
57 Fed. Reg. 13,498 (April 16, 1992) as amended. In order to
assist states in developing SIPs, EPA occasionally issues
guidelines and policy statements.

17. See also, CAAA legislative history at H.R. Rep. No. 490,
101st Cong., 2d Sess., 202-204(1990); S. Rep. No. 228, 101st
Cong., 1st Sess., 13, 48 (1989).

the way EPA regulates ozone precursors based on the theory of incremental reactivity, emphasizing the critical role of NO$_x$ in ozone formation. See National Resource Council Rethinking the Ozone Problem in Urban and Regional Air Pollution (1991). Thus, because emissions of beverage alcohol do not appreciably affect ambient ozone levels, EPA should amend the definition of VOC to exclude beverage alcohol.

B.   Emissions of Ethanol from Beverage Alcohol Have Very Low Incremental Reactivities and Do Not Appreciably Contribute to the Formation of Ozone

The reactivity of volatile organic compounds have been defined in several ways. EPA's early VOC policies defining VOCs were based on a theory of reactivity which has been developed and refined further over the past decade. The policies acknowledged that a better understanding of the atmospheric transformation of compounds would occur that would allow EPA to refine its VOC reactivity policy and exempt other compounds in the future.[18] These policies also are implicit in the Administrator's statutory and administrative authority to define the compounds that contribute to the formation of photochemical oxidants.

The most recent scientific theory of atmospheric reactivity, embraced by the CAAA and also most realistic in view of observations and accepted modeling of ozone formation, consists in relating the change in ozone levels due to a change in the level of a specific VOC under typical atmospheric conditions where other VOCs are present. This concept of VOC reactivity has been called "incremental reactivity" because it corresponds to the reactivity of a VOC as an increment over the background reactivity of other VOCs.[19]

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18. See 42 Fed. Reg. 35,314, 35,315 (July 8, 1977).

19. Another approach, "Photochemical Ozone Creation Potentials" or "POCP" also has been suggested as a means of determining ozone production in the atmosphere. The POCP approach is based upon the same concept of the reactivity of a VOC as an increment over the background reactivity of a VOC/NO$_x$ mixture. The relative POCPs of different compounds differ depending upon the method of calculation and the NO$_x$

In the past, VOCs have sometimes been compared according to their reactivity with the hydroxyl (OH) radicals. Gaseous alcohols, including ethanol, principally react with hydroxyl free radical, not with ozone or sunlight. Ethanol does not undergo significant photolysis. Thus, ethanol exhibits a low potential to produce ozone, as a consequence of its low hydroxyl reactivity. However, the OH reactivity provides only a measure of the rate of a single reaction of the VOC and it ignores many other aspects of the VOC reactivity, which have significant consequences for total ozone formation, including the following:

1.   The fact that alkenes also react with ozone (O_3).

2.   The fact that aldehydes also are oxidized through photolysis.

3.   The fact that the reactivity of the oxidation products of the VOC + OH reaction has a major effect on the rate of O_3 formation.

Therefore, the concept of incremental reactivity offers a more realistic approach to the quantitative assessment of the reactivity of VOCs with respect to O_3 formation, than other reactivity scales that are based on single reaction rates (such as the OH reaction rate).

Incremental reactivity can be assessed through computer simulation of the ozone formation using comprehensive chemical kinetic mechanisms of atmospheric chemistry. There are several ways, however, to measure this incremental reactivity. First, the simulation can be conducted in two ways: (1) using initial concentrations of VOCs and NO_x and simulating the evolution of the chemical concentrations over a given time period (so-called box model simulation) and (2) using initial concentrations of VOCs and

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dependent chemical environment. Under the POCP theory, alcohols are among the weakest producers of ozone. See Yvonne Andersson-Skold, Peringe Grennfelt, Karin Pleijel, Photochemical Ozone Creation Potentials; A Study of Different Concepts, 42 J. Air Waste Manage. Assoc. 1152-1158 (1992). See also R.G. Derwent & M.E. Jenkin, Hydrocarbons and the Long Range Transport of Ozone and PAN Across Europe, Atmos. Environ. 25A:1661-1678 (1991).

NO_x as well as emissions of VOCs and NO_x during the course of the simulation (so-called trajectory model simulation). (The second type of simulation is considered to be a better representation of atmospheric conditions.) Second, the ozone formation can be assessed with respect to (1) the maximum concentration of O_3 formed or (2) the total amount of O_3 formed over the course of the simulation. Third, the length of the simulation (one day, two days) may affect the influence of a VOC on O_3 formation.

Carter and Atkinson (1987, 1989)[20] have performed experimental and computational studies of VOC incremental reactivities. The results of a comprehensive investigation of such incremental reactivities is presented in Table 1 for 15 VOCs, including ethanol, at several VOC/NO_x ratios. As shown in Table 1, the incremental reactivity of a VOC decreases as the VOC/NO_x ratio increases, i.e., as the atmosphere becomes NO_x limited. However, this dependence varies among the VOCs investigated.

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20. W.P.L. Carter and R. Atkinson, Computer Modeling Study of Incremental Hydrocarbon Reactivity, Environ. Sci. Technol., Vol. 23, 864-880 (1989); W.P.L. Carter and R. Atkinson, An Experimental Study of Incremental Hydrocarbon Reactivity, Environ. Sci. Technol., Vol. 21, 670-679 (1987).

Table 1.

Incremental Reactivities for Fifteen VOC
as a Function of the VOC/NO$_x$ Ratio
(Carter and Atkinson, 1989)[21]

ROG/NO$_x$ ratio	incremental reactivity/carbon							
	4	6	8	10	12	16	20	40
base-case max O$_3$, ppb	72	160	214	215	209	194	190	139
ethane	0.024	0.054	0.041	0.031	0.026	0.018	0.015	0.007
n-butane	0.10	0.22	0.16	0.12	0.098	0.069	0.052	0.019
n-octane	0.068	0.14	0.12	0.084	0.060	0.027	0.007	-0.031
n-pentadecane	0.038	0.059	0.068	0.037	0.020	0.001	-0.16	-0.051
ethene	0.85	1.65	0.90	0.64	0.50	0.33	0.30	0.14
propene	1.98	2.04	1.08	0.61	0.51	0.39	0.25	0.14
trans-2-butene	1.42	2.02	0.97	0.62	0.48	0.81	0.23	0.054
benzene	0.088	0.088	0.088	0.011	0.006	-0.002	-0.004	-0.002
toluene	0.26	0.52	0.16	0.040	-0.021	-0.036	-0.058	-0.051
m-xylene	0.98	1.61	0.63	0.32	0.20	0.091	0.012	-0.025
formaldehyde	2.42	3.28	1.20	0.77	0.48	0.32	0.24	0.051
acetaldehyde	1.34	1.83	0.88	0.55	0.42	0.29	0.24	0.98
benzaldehyde	-0.11	-0.15	-0.27	-0.34	-0.37	-0.41	-0.41	-0.40
methanol	0.12	0.27	0.17	0.12	0.091	0.086	0.055	0.029
ethanol	0.18	0.37	0.22	0.14	0.10	0.065	0.038	0.006

Typical VOC/NO$_x$ ratios range from about 7 to 14
as shown in Table 2. The default value of the VOC/NO$_x$
ratio recommended by EPA for use in the EKMA photochemical
trajectory model is 9.5; this value is consistent with the
values reported in Table 2. However, some areas exhibit
VOC/NO$_x$ ratios that may be as high as 70 because of high
anthropogenic VOC emissions (e.g., petroleum industry
sources) or high natural VOC emissions (e.g., biogenic
sources). K. Baugues, A Review of NMOC, NOx and NMOC/NOx
Ratios Measured in 1984 and 1986. (1986) EPA-450/4-86-015,
U.S. Environmental Protection Agency, Research Triangle Park,
North Carolina.

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21.   See id.

Table 2

Location	Median VOC/NOx(1)	O₃ Non-attainment Category(2)
Akron, OH	12.8	Moderate
Atlanta, GA	10.4	Serious
Boston, MA	7.6	Serious
Charlotte, NC	10.4	Moderate
Cincinnati, OH	9.1	Moderate
Cleveland, OH	7.5	Moderate
Dallas, TX	11.8	Moderate
El Paso, TX	11.9	Serious
Fort Worth, TX	11.8	Moderate
Houston, TX	12.9	Severe
Indianapolis, IN	10.9	Marginal
Kansas City, MO	8.5	Sub - Marginal
Memphis, TN	13.9	Marginal
Miami, FL	13.3	Moderate
Philadelphia, PA	8.0	Severe
Portland, ME	11.6	Moderate
Richmond, VA	11.2	Moderate
St. Louis, MO	9.6	Moderate
Washington, DC	8.7	Serious
Wilkes Barre, PA	14.3	Marginal
Fresno (San Joaquin Valley), CA	12.9(*)	Serious
San Francisco, Bay Area, CA	12.2(*)	Moderate
Los Angeles, South Coast Air Basin, CA	7.8	Extreme

(1)   National Research Council, Rethinking the Ozone Problem
      in Urban and Regional Air Pollution 358 (1991).
(2)   EPA classification.
(*)   Data from ENSR field measurements.

          If one considers that a typical VOC/NO_x ratio is
in the range of 7 to 14, then the results presented by Carter
and Atkinson (1989) show that ethanol would have an
incremental reactivity that is extremely low in comparison to
virtually all other VOCs, and is commensurate with the
reactivity of methanol, which EPA has recognized does not
contribute large quantities of oxidant under many atmospheric
conditions. 42 Fed. Reg. 35,314 (July 8, 1977). Indeed,
where the VOC/NO_x ratio is greater than 12, ethanol has
even less reactivity than methanol in the atmosphere. For
example, the results presented by Carter and Atkinson (1989)
demonstrate that ethanol has an incremental reactivity only
10% higher than that of methanol at a VOC/NO_x ratio of 12
and, at higher VOC/NO_x ratios, ethanol has a lower
incremental reactivity than methanol.

          Andersson-Skold, Grennfelt and Pleijel (1992) also
have calculated incremental reactivities (so-called
photochemical ozone creation potentials in their work) using
trajectory model calculations. Emissions typical of southern
Sweden were used in their analysis. The incremental
reactivities relative to ethene (reference reactivity of 100)
are presented in Table 3 for thirteen of the same VOCs as
those presented in Table 1 (results were not available for
n-pentadecane and benzaldehyde).

          The results presented in Table 3 show that ethanol
is actually less reactive (negative incremental reactivity)
than methanol for the first day of simulation, more reactive
than methanol in terms of second-day maximum O_3
concentration, but of comparable reactivity in terms of
overall O_3 formation over four days. Alcohols are
considered to be of low reactivity compared to VOCs such as
alkanes, alkenes, and aromatics.

          Thus, the tables show that ethanol does not
appreciably contribute to the formation of ozone in
nonattainment areas because of its low incremental
reactivity. To regulate beverage alcohol from the distilled
spirits industry, in such areas for the sake of regulation
will have little benefit for suppressing ozone formation, and
may even be counterproductive.

Table 3. Incremental Reactivities for Thirteen VOCs for Various O_3 Formation Measures

VOC	1stDay Maximum O_3 Formation	2nd Day Maximum O_3 Formation	2-Day Average O_3 Formation	4-Day Average O_3 Formation
ethane	-2.2	15.1	3.0	12.6
n-butane	-11.0	65.8	14.7	46.7
n-octane	36.8	98.6	7.0	46.1
ethene	100.0	100.0	100.0	100.0
propene	-13.2	139.7	35.3	59.9
2-butene	-25.0	134.2	17.7	43.6
benzene	20.6	60.3	28.0	40.2
toluene	11.0	84.9	32.3	47.0
m-xylene	-8.1	111.0	27.3	47.4
formaldehyde	25.0	20.5	27.2	26.1
acetaldehyde	-32.4	101.4	-5.5	18.6
methanol	10.3	30.1	14.6	21.3
ethanol	-33.1	58.9	-3.9	22.5

III. OTHER REGULATORY AND ECONOMIC CONSIDERATIONS

A. **Ethanol Losses During the Production, Bottling, and Storage of Distilled Spirits Already Are Monitored Closely and Safeguarded by Other Federal Agencies**

Distilled spirits are the highest taxed consumer product in the United States and are regulated heavily by the federal government. The Bureau of Alcohol, Tobacco and Firearms (BATF) is charged with the responsibility of collecting the federal excise taxes due on alcohol beverages. The distilled spirits industry, its plants, equipment, and processes are stringently regulated by BATF, which has rules requiring distillers to prevent and control leaks and spills, and account for all product in order to protect federal revenues. (See, e.g., 27 C.F.R. Part 19, Subpart I.) The federal excise tax for distilled spirits currently is $13.50 per proof gallon, and the liability of a domestic producer for that tax attaches at the time the product comes off the still, though it is not payable until the product leaves a bonded premise which typically occurs when the distilled spirits are shipped to a wholesaler. See 26 U.S.C. § 5001.

While BATF regulations do not ostensibly regulate ethanol emissions, any excess losses are subject to tax.[22] This federal regulatory regime recognizes aging losses as part of the production process and utilizes economic disincentives, much like very high effluent taxes, to ensure against non-allowable product losses. Thus, distillers have an economic incentive to avoid excess emissions into the air in order to prevent costly losses of the product during aging.

Accordingly, both industry and government have a strong interest in conserving the maximum amount of beverage alcohol throughout the entire production and bottling process. The burden of further additional costly regulation will be more than the industry can bear.

B.   Costs of Air Pollution Regulation Would Be
       Devastating to the Distilled Spirits Industry

Separate from the fact that the imposition of certain technology controls considered by EPA as potentially available RACT would destroy the industry by undermining the integrity of the product, the cost of purchasing and installing equipment such as carbon adsorption units or venting emissions to incinerators or refrigeration units would be devastating to DISCUS members. The distilled spirits industry as a whole has been hard hit by declining consumption (adult per capita consumption of spirits has declined 37.2% between 1974 and 1991) and the 8% increase in the federal excise tax in 1991 (contributing to a 7.5% decline of sales in 1991). Any additional regulatory costs under the Clean Air Act would cripple the industry even assuming the existence of available demonstrated technology that would not adversely affect the product.

The imposition of such regulation could shutdown portions of the industry, in particular those that produce aged spirits, and would have several significant ramifications on the United States economy. First, the distilled spirits industry generates (directly and

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22.   See 26 U.S.C. §§ 5006, 5008; see also 27 C.F.R. § 19.561- § 19.562; see generally, 27 C.F.R. pt. 19, subpt. Q.

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indirectly) approximately 1,350,000 jobs and $18,330,000,000 in wages.[23] Second, the distilled spirits industry generates $3,760,000,000 in federal excise tax revenue and $6,600,000,000 in state and local revenues.[24] Because many beverage alcohol facilities are located in largely rural states, such as Kentucky and Tennessee, the loss of this revenue would be keenly felt by those states. Finally, the total economic activity generated both directly and indirectly by the industry is $74,000,000,000. Thus, the economic cost to the industry from regulation (either directly from the cost of technology or indirectly from the inability to produce a palatable product due to the technology) would have a significant ripple effect on the United States economy and on the federal and state revenues.

Moreover, EPA CAAA regulations would run counter to the government's efforts to encourage exports of United States products. The export of distilled spirits is promoted by the United States government in numerous ways. For example, the United States Congress officially recognized Bourbon whisky as a distinctive product of the United States in a resolution on May 4, 1964.[25] The distinctive qualities of Bourbon have led to large sales increases in foreign markets. Bourbon producers are employing strategies to retain the large market share achieved in some countries, particularly Japan, Europe and Australia, and to improve sales in markets where consumers are only beginning to experience the taste of Bourbon.

Bourbon exports also are supported by the U.S. Department of Agriculture, which has allotted funds from its

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23. Distilled Spirits Council of the United States, 1991. These figures include jobs generated through purchases by distillers, bottlers, wholesalers, and retailers, as well as the jobs of those who are directly involved with distilling, bottling, wholesaling, or retailing for the industry.

24. Distilled Spirits Council of the United States, 1991. This figure includes $3,670,000,000 in direct revenues (excise taxes, control state net profits, sales taxes, license fees, etc.) and $2,930,500,000 in indirect revenues (personal and corporate income taxes, property taxes, sales taxes on items purchased by producers, wholesalers and retailers, etc.).

25. S. Con. Res. 19, 88th Cong., 2d Sess. (1964).

Market Promotion Program (MPP) for FY '92 and the previous two fiscal years. The funds have been used in both branded and generic promotions by U.S. distillers to develop, maintain and expand international markets for Bourbon whisky. In those countries in which these funds were used for market production, sales increased 39% in 1991 in comparison to the year 1990. See Department of Agriculture Market Promotion Program Agreement No. 097 at Exhibit A. Thus, the imposition of 1990 CAAA regulation will result in economic hardship that is counterproductive to ongoing efforts by the federal government to assist and promote the U.S. distilled spirits industry.

IV. CONCLUSION

Consistent with the CAAA's acknowledgment of incremental reactivity of VOCs and NO_x, the 1991 National Academy of Sciences' Report on ozone formation and current scientific approaches to ozone formation, the Distilled Spirits Council of the United States Inc., requests EPA to amend its regulatory definition of "volatile organic compounds" by adding beverage alcohol to its list of exempted compounds. Specifically, DISCUS requests EPA to take the following actions:

(1) Amend its regulations by means of direct final rulemaking so as to exclude beverage alcohol from the term "volatile organic compounds." 40 C.F.R. § 51.100(s).

(2) Expressly exempt beverage alcohol and clarify that EPA lacks authority to approve or promulgate VOC regulations to the extent they apply to beverage alcohol or make such statements as may be necessary to implement the addition of beverage alcohol, to the list of exempt VOCs with regard to the following: final action on any currently pending proposal to approve state VOC regulations as part of the state implementation plan; and any future proposal to approve or promulgate VOC regulations for the purpose of reducing tropospheric ozone.

(3) Amend its regulations relating to new source review immediately by means of direct final rulemaking so as to exclude

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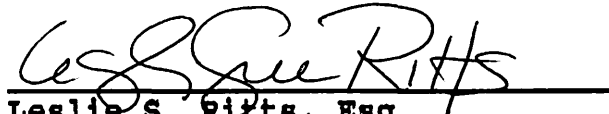
beverage alcohol from the term "volatile
organic compounds." 40 C.F.R.
§ 51.165(a)(xix) and § 51.166(b)(29).

(4)   Take such other actions as may be necessary
      to ensure that beverage alcohol is exempt
      from regulation as a photochemically
      reactive VOC.

        If you have questions please feel free to call me
at the number below. We request an opportunity to meet with
your staff at their earliest possible convenience, as state
decisions that may affect our industry are currently being
made given the Title I SIP submission deadline of November
15, 1992 in the 1990 CAAA. We also request that EPA notify
the state and regional EPA air directors that in the course
of its review of DISCUS' petition, EPA will not require
states to adopt new Clean Air Act regulations affecting
beverage alcohol.

                              Sincerely,

                              Leslie S. Ritts, Esq.
                              Chadbourne & Parke
                              Counsel for the Distilled
                                Spirits Council of the
                                United States, Inc.
                              (202) 962-4559

cc: The Honorable William G. Rosenberg
      Assistant Administrator for Air and Radiation

      Alan W. Eckert, Esq.
      Associate General Counsel, Air and Radiation Division

      Mr. John S. Seitz
      Director, Office of Air Quality Planning and Standards

      Mr. David Kent Berry
      Deputy Director, Air Quality Management Division

UNITED STATES DEPARTMENT OF AGRICULTURE
COMMODITY CREDIT CORPORATION
WASHINGTON, D.C. 20250

MARKET PROMOTION PROGRAM (MPP) AGREEMENT NUMBER 097

This agreement is entered into between the Commodity Credit Corporation, United States Department of Agriculture (hereinafter called "CCC"), and the Kentucky Distillers' Association, (hereinafter called the "Participant").

WITNESSETH:

WHEREAS, section 203 of the Agricultural Trade Act of 1978, as amended, authorizes the use of funds of, or commodities owned by, the CCC to develop, maintain and expand commercial markets for agricultural commodities or products thereof; and

WHEREAS, in order to carry out these purposes, CCC and the Participant have agreed to cooperate in a program which will aid in the development, maintenance and expansion of commercial export markets for United States bourbon whiskey (hereinafter called "bourbon whiskey");

Now, therefore, CCC and the Participant agree as follows:

  I.   OBJECTIVE OF THE AGREEMENT. The objective of this agreement is to
       develop, maintain, and expand commercial export markets for United
       States bourbon whiskey.

  II. ACTIVITIES TO BE CONDUCTED. In carrying out the objective of this
       agreement, CCC will make funds available, or issue dollar denominated
       generic commodity certificates, as provided in Article IV, to reimburse
       the Participant for authorized expenses incurred to conduct those
       activities and related evaluations as may be approved by the
       Administrator, Foreign Agricultural Service, USDA, who is also Vice
       President, CCC (hereinafter called the "Administrator"), in the
       Participant's annual MPP activity plan(s) or amendments thereto.

  III. THIRD PARTY PARTICIPANTS. Activities may be carried out by the
       Participant alone, or in cooperation with U.S. private trade
       organizations or with foreign organizations pursuant to agreements
       entered into between the Participant and such organizations. Activities
       conducted under such agreements shall be supervised by the Participant.

IV. **MPP PROGRAM RESOURCES.**

    A. CCC will make funds available, or issue dollar denominated generic commodity certificates, as set forth below, to reimburse the Participant for expenses incurred for the implementation of this agreement, as provided herein.

MPP Resources Authorization Fiscal Year	Total MPP Resources Authorized

Resources derived from this fiscal year's authorization shall be available for obligation by the Participant through September 30, 1993.

91-097	$3,100,000

    B. The total U.S. dollars or equivalent in CCC generic commodity certificates issued to the Participant shall not exceed the amount made available in Article IV. A.

    C. CCC's responsibility to the Participant shall be limited to the issuance of U.S. dollar checks, or CCC generic commodity certificates, with a dollar amount equivalent to the amount of the Participant's claim submitted in accordance with this agreement.

    D. If CCC has reimbursed a Participant, or has offset an advance payment, and CCC subsequently determines that the claim did not represent an authorized expenditure, the Participant shall, upon demand of the Administrator, immediately refund to CCC the dollar amount of CCC's reimbursement as provided in this agreement.

V. **CONTRIBUTIONS.** The Participant shall provide contributions of its own resources, under this program agreement equivalent to the amount specified by the Administrator in the activity plan approval letter, unless otherwise approved in writing by the Administrator.

VI. **OTHER PROVISIONS.** All the terms and conditions of the Uniform MPP Agreement Provisions, attached hereto as Exhibit A, are made part of this program agreement as if fully stated herein. The terms and conditions governing operations under the Agreement may be changed by the Administrator effective at least 30 days after notification to the Participant. Expenditures incurred after such effective date must fully comply with the changed terms and conditions or be subject to disallowance.

VII. **COMPLETION AND TERMINATION.** Activities conducted under this agreement shall be completed by September 30, 1993, unless this agreement is sooner terminated by either party upon giving 30 days' notice in writing to the other party.

IN WITNESS WHEREOF, the parties hereto have executed this agreement as of the

__21st__ day of __March__, 1991.

COMMODITY CREDIT CORPORATION   KENTUCKY DISTILLERS' ASSOCIATION

By: _____   By _____
   Administrator, Foreign   Title: _____
   Agricultural Service, and
   Vice President, Commodity
   Credit Corporation

Date: ___3/21/91___   Date: __March 8, 1991__

UNITED STATES DEPARTMENT OF AGRICULTURE
COMMODITY CREDIT CORPORATION
Washington, D.C.   20250

Market Promotion Program Agreement Number 097

AMENDMENT 1

WHEREAS, the Commodity Credit Corporation, United States Department of Agriculture (hereinafter called "CCC"), and the Kentucky Distillers' Association (hereinafter called the "Participant"), entered into Market Promotion Program (MPP) agreement number 097 on March 21, 1991; and

WHEREAS, the agreement covered activities designed to develop, maintain, and expand commercial export markets for Kentucky bourbon whiskey; and

WHEREAS, the CCC and the Participant desire to provide additional funds, extend the termination date and make other changes thereto;

Now, therefore, CCC and the Participant agree that said agreement is hereby amended in its entirety to read as follows:

I.   OBJECTIVE OF THE AGREEMENT. The objective of this agreement is to develop, maintain, and expand commercial export markets for Kentucky bourbon whiskey.

II. ACTIVITIES TO BE CONDUCTED. In carrying out the objective of this agreement, CCC will make funds available, or issue dollar denominated generic commodity certificates, as provided in Article IV, to reimburse the Participant for authorized expenses incurred to conduct those activities and related evaluations as may be approved by the Administrator, Foreign Agricultural Service, USDA, who is also Vice President, CCC (hereinafter called the "Administrator"), in the Participant's annual MPP activity plan(s) or amendments thereto.

III. THIRD PARTY PARTICIPANTS. Activities may be carried out by the Participant alone, or in cooperation with U.S. private trade organizations or with foreign organizations pursuant to agreements entered into between the Participant and such organizations. Activities conducted under such agreements shall be supervised by the Participant.

IV. **MPP PROGRAM RESOURCES.**

    A. The maximum amount of funds, or dollar denominated generic commodity certificates, to be made available to the Participant for reimbursement of expenses incurred for the implementation of this agreement, is as follows:

MPP Resources Authorization Fiscal Year	MPP Resources Previously Authorized	Increase or Decrease by This Amendment	Maximum MPP Resources Authorized

Resources derived from this fiscal year's authorization shall be available for obligation through September 30, 1993.

| 91-097 | $3,100,000 | --- | $3,100,000 |

Resources derived from this fiscal year's authorization shall be available for obligation through September 30, 1995.

| 92-097 | --- | $3,790,000 | $3,790,000 |
| **TOTAL** | $3,100,000 | $3,790,000 | $6,890,000 |

    B. The total U.S. dollar or equivalent in CCC generic commodity certificates issued to the Participant shall not exceed the amount made available in Article IV.A.

    C. CCC's responsibility to the Participant shall be limited to the issuance of CCC generic commodity certificates with a U.S. dollar amount equivalent to the amount of the Participant's claim submitted in accordance with this agreement.

    D. If CCC has reimbursed a Participant, or has offset an advance payment, and CCC subsequently determines that the claim did not represent an authorized expenditure, the Participant shall, upon demand of the Administrator, immediately refund to CCC the dollar amount of CCC's reimbursement as provided in this agreement.

V. **CONTRIBUTIONS.** The Participant shall provide contributions of its own resources under this program agreement equivalent to the amount specified by the Administrator in the activity plan approval letter.

VI.   OTHER PROVISIONS. This agreement is subject to the requirements and conditions set forth in 7 CFR Part 1485 and in the Uniform MPP Agreement Provisions, attached hereto as Exhibit A. Furthermore, the Participant must provide certification of a drug-free workplace, attached hereto as Exhibit B, as required by the regulations implementing Section 5151-5160 of the Drug-Free Workplace Act of 1988.

VII. COMPLETION AND TERMINATION. Activities conducted under this agreement shall be completed by September 30, 1995, unless this agreement is sooner terminated by either party upon giving 30 days' notice in writing to the other party.

IN WITNESS WHEREOF, the parties hereto have executed this agreement as of the
_____9_____ day of _____MAR ⁴_, 1992.

COMMODITY CREDIT CORPORATION   KENTUCKY DISTILLERS' ASSOCIATION

By: _____   By: _____
    Administrator, Foreign   Title: _____
    Agricultural Service, and
    Vice President, Commodity   *Program Administrator*
    Credit Corporation

Date: _____MAR 09 1992_____   Date: _January 29, 1992_